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ELECTRONIC INDUSTRIES

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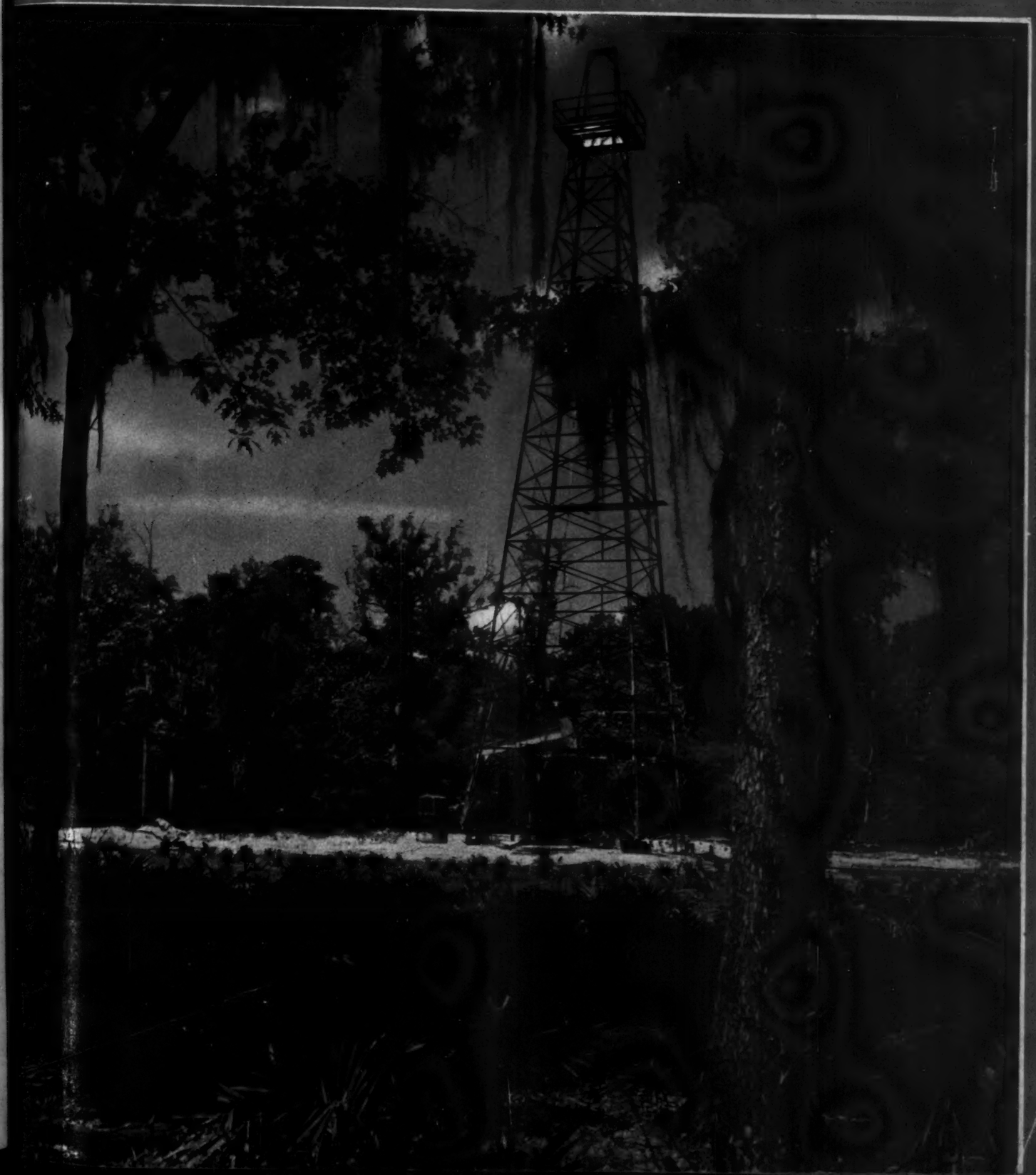
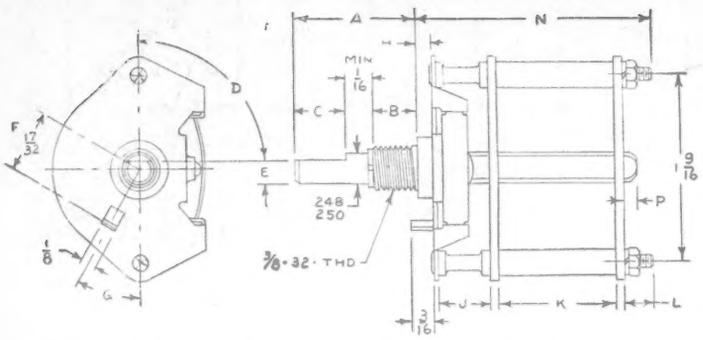
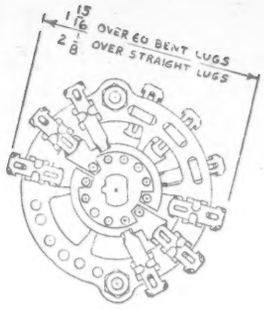




FRONT VIEW OF INDEX PLATE

ELEVATION VIEW OF RS-50 SWITCH



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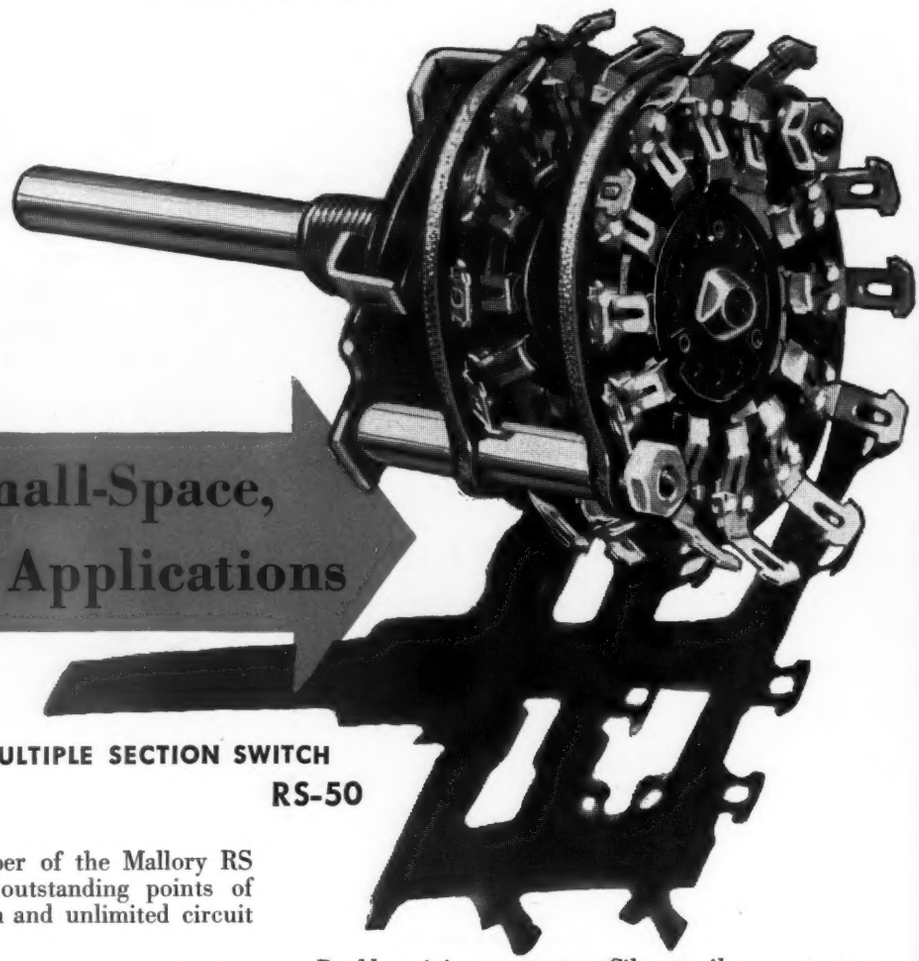

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ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

★ IN THIS ISSUE JULY, 1946 ★

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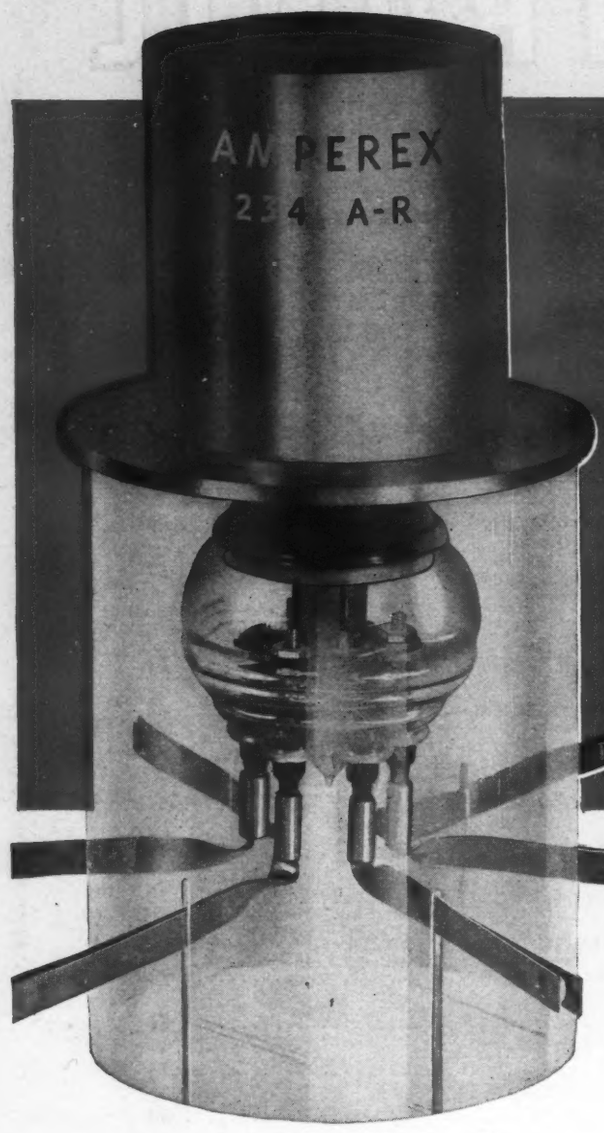

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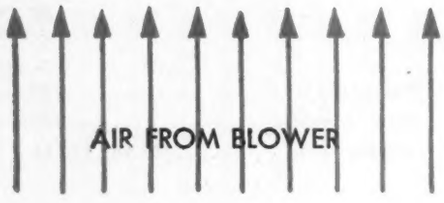

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS R.F. Power Amplifier and Oscillator Class C— Industrial, FM and Telegraphy				
	Maximum Rating per Tube		Typical Operation	
			One Tube	Two Tubes
Operating Frequency (mc)	110	200	27	110
Filament Voltage	15.0	15.0	15.0	15.0
D.C. Plate Voltage	3500	2000	3500	3500
D.C. Grid Voltage	—450	—250	—330	—275
Peak RF Grid Voltage	—	—	830	675
D.C. Plate Current (amps)	.900	.800	.860	1.43
Plate Input (watts)	3000	1600	3000	5000
Plate Dissipation (watts)*	1000	1000	1000	1700
D.C. Grid Current (ma) (approx.)	200	160	110	220
Driving Power (watts) (approx.)	—	—	87	140
Plate Power Output (watts)	—	—	2000	3300
*Based on air flow data.				

***WRITE FOR** Detailed Technical Rating and Data Sheets. Industrial and communication engineers are invited to consult with the Amperex Application Engineering Department on all tube, circuit and related problems. Amperex designs and engineers a complete line of power tubes: Communication, Rectification, Industrial, Electro-Medical, Special Purpose.*

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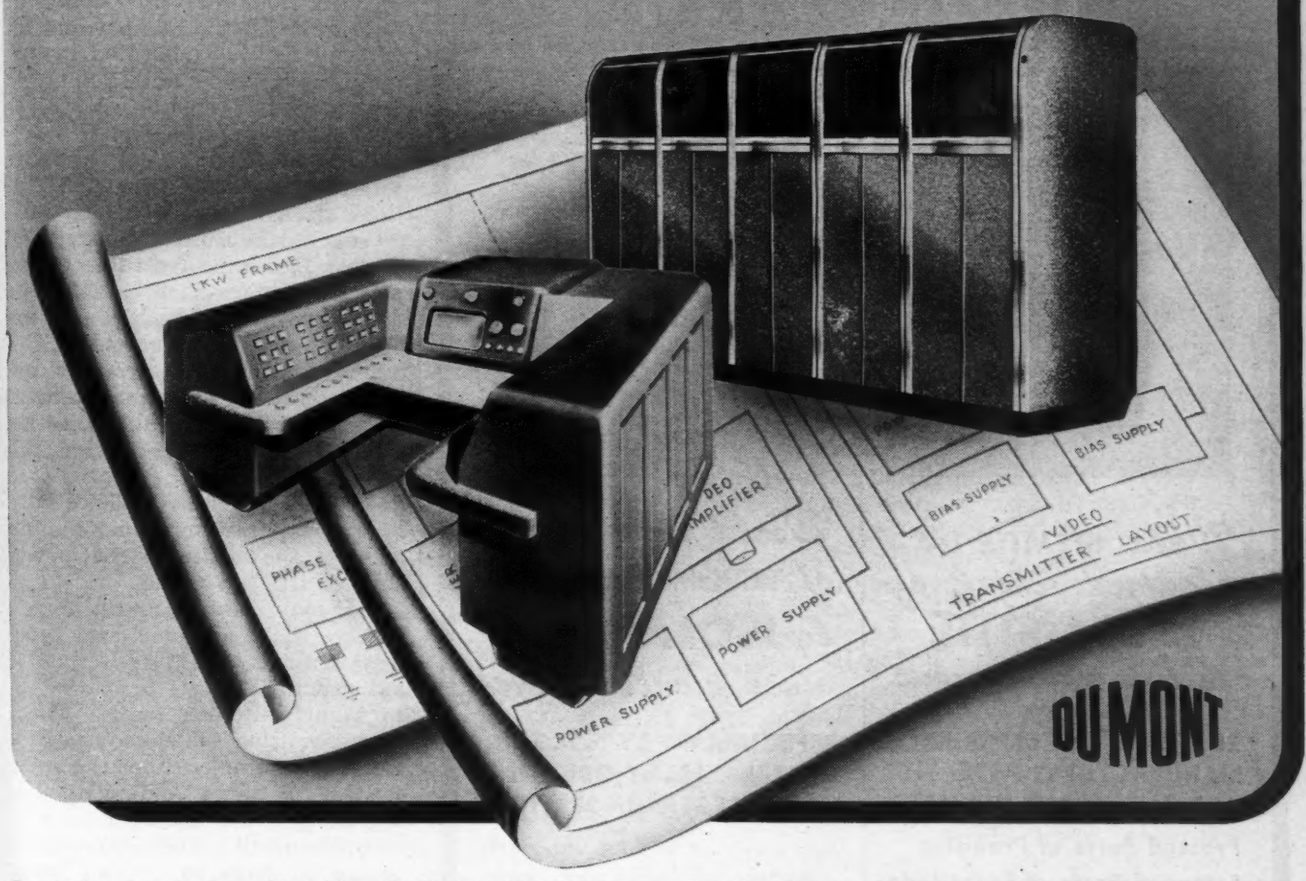

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2. a new high in efficient, dependable, trouble-free performance,
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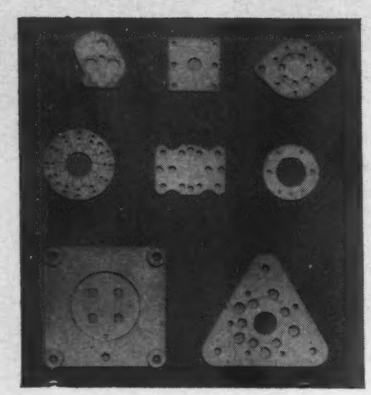

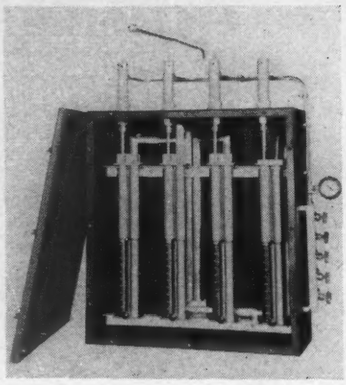

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"FOUNDERS OF THE INDUSTRY" 343 CORTLANDT ST., BELLEVILLE 9, N. J.

THE COVER

Petroleum—an Electronic Industry

The oil-well derrick on our front cover symbolizes an industry which is today dependent on electronic technics from the very location of underground petroleum deposits, all through many complicated manufacturing processes until a hundred diverse products emerge with values of many billions annually.

Electronic geophysical methods serve to indicate best drilling positions by locating subsurface salt-domes which usually point up oil basins. Electronic recording of explosion tremors show position of domes and underground structure. With oil-wells now reaching two miles or so in depth, electronic devices steer the drills into vertical or deflecting paths. And sensitive Geiger-counter devices lowered into the shaft, permit the geologist to detect the different radio-activity of various strata, enabling him to identify the rock material, even through the well casing.

Electronic methods again appear in force in the manufacturing processes through which the crude is put, before it comes to market in so many different forms. These processes using the electron microscope, electronic spectrographs, cathode-ray tubes, and photo-electric devices, are discussed in considerable detail in the article which begins on page 58 of this issue.

10^{-7} CM. Resolved

James Hillier, RCA Laboratories, Princeton, N. J., reports experiments establishing a new possible limit for the resolving power of the electron microscope. Lack of axial symmetry in the magnetic field of previous lenses had limited the resolving power. Therefore, a lens of greater axial symmetry has been produced. A few images have been obtained with this lens which show a resolving power of ten Angstrom units or of a 10,000,000th of a centimeter, corresponding to a useful magnification of over 200,000 times. This work indicates that calculated limiting resolving power of the present magnetic lenses, which lies in the range 5 to 10 Angstroms, is attainable in practice. On the other hand, it has revealed an imposing list of technical problems which must be solved before such high resolving power will be consistently obtainable.

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

O. H. CALDWELL, EDITOR ★ M. CLEMENTS, PUBLISHER ★ 480 LEXINGTON AVE., NEW YORK (17), N. Y.

Automatic Heating

It is encouraging to see the trend of the ever-broadening scope of automatic and semi-automatic feeding mechanisms which are being used with electronic heating units. No other type of heat fits so definitely in the production line for many soldering, brazing and heating operations. In many cases "product flow" from raw material to finished article is now a smooth continuous progression. Perhaps more than any other application, induction and dielectric heating is showing industry what the vacuum tube can do.

Electronic High-Speed Pilot

Already aviation designers are talking about airplane speeds of 1500 to 3500 miles per hour—speeds which appear someday feasible with jet propulsion. But the unsolved problem will be the navigation of a ship moving at such incredible velocities.

Electronic devices offer the only solution. Human reactions are far too slow; any slight delays or errors would throw the pilot hundreds of miles off course. An electronic device that observes, computes and steers, all automatically, will be needed if jet possibilities are to be realized.

Fitting Electronic Methods to Industry

Many reasons have been advanced to explain why the communication side of our electronic growth is expanding so much more rapidly than is the industrial. However, most of us forget that when the electronic engineer moves into the industrial field he is leaving a world in which he has long been king. In communications he could roam at will, making his own rules and guiding his own conduct. With industrial applications, his ideas and designs must for the first time fit into already established production lines, quality test procedures, and inspection setup. Perhaps this new strangeness could be quickly bridged with greater liaison between electronic engineering and production-management groups.

Hurrah for the Eniac

The "electronic numerical integrating and computing" machine illustrated in this issue is really the answer to the dreams of arithmetic haters. Its power to free inventors, scientists and engineers from the stupefying drudgery of endless repetitive computations is fabulous. About 1000 times as fast as the last M.I.T. differential analyzer, it promises, if made generally available, to end forever the work of calculating mathematical tables, complex structural stress relations, abstruse motions of bodies, both earthbound and astronomical. And above all, it will save vast quantities of materials which are now added to machines, structures and designs as large safety factors because exact calculations have been too involved.

TV Color Standards Now?

Ardent color-video advocates who have been so enthusiastic about setting up immediate permanent color-TV standards have been taken aback by the suggestion casually made by CBS' Dr. Goldmark before a recent SMPE session that "there are certain advantages" to a 24-frame, 144-field (3-color, interlaced) system and that comparisons are now being made with CBS' present widely-publicized 20-frame 120-field system. To convert, would not be a simple change, since it involves details in perhaps one half of the circuits. The mere suggestion that improvements might be developed would seem to take most of the punch out of previous arguments that immediate color-TV standardization is possible.

★★★

ONE TUBE – ONE RELAY

By VICTOR WOUK*
Research Engineer
Westinghouse Electric Corp., East Pittsburgh, Penna.

By resistance capacitor arrangements in the grid and plate circuits, one tube will give multiple intervals

• Electronic timers utilizing one electron tube and one electromagnetic relay commonly are designed to control the length of only one time interval, or to determine the duration of only one electrically controlled process. However, one tube and one relay also can be used in a timer to control the lengths of more than one interval, and thus can serve to time a sequence of operations.

The basic circuit of single-interval electronic timers is shown in Fig. 1. Before the timing operation is started, the thyratron is held non-conducting by the negative grid voltage. The timing process is initiated by the opening of Switch S_1, after which operation the thyratron remains non-conducting due to the negative grid voltage maintained by the charge on capacitor C_1.

The charge on C_1 begins to leak off through resistance R_1 after S_1 is opened, and the magnitude of the negative grid voltage decays in an exponential manner with time, as is illustrated in Fig. 1. When C_1 has discharged to the grid firing voltage e_f, the thyratron fires, and the relay pulls in. The time interval, "t," equal to the interval between the opening of S_1 and the firing of the thyratron is determined by R_1, C_1, the initial voltage, E_o, on C_1, and tube characteristics, and is given by

$$t = R_1 C_1 \ln \left(\frac{E_o}{e_f} \right) \qquad (1)$$

In adjustable interval timers, R_1 or E_o is varied for different timed intervals.

The circuit of Fig. 1 is schematic, and the circuits of commercially available electronic timers differ from it in many details. For example, a hard vacuum tube, instead of a thyratron, may be used. In this case, relay characteristics enter into the determination of "t." Or, upon operation of the timing switch, the tube may be conducting and the relay actuated, dropping out after the timed interval, instead of pulling in after the timed interval. The relay may be operated from an ac supply if C_2

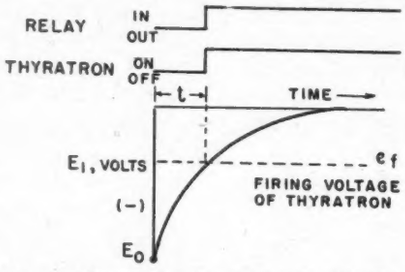


Fig. 1b—The mode of operation for the time just after throwing the starting switch

and R_2, in Fig. 1, are added. In any single-interval electronic timer, no matter what the details of construction may be, an electron tube controls an "in-out" sequence of a relay, and contacts on the relay serve to control an "on-off" process, timing either the "on" or "off" period.

The controls that can be effected with this simple timer are quite numerous, according to the number of contacts on the relay. However, the usefulness of the simple electronic timer of Fig. 1 is limited by the fact that after the timed interval the relay pulls in and stays in, or drops out and stays out, until some resetting operation is performed manually. For multiple-interval or multiple-sequence timing, two or more relay circuits of the type of Fig. 1 usually are employed, with the operation of the first starting the operation of the second, the operation of the second starting that of the third, etc., and with complicated interconnecting circuits for proper control.

It is possible to obtain multiple interval timing using only one electron tube and one relay by means of special resistance-capacitor arrangements in the grid and plate circuits of the tube.

"Plate-throttle" timer

If a capacitor and paralleled resistor are added in series with the relay coil, in the basic circuit of Fig. 1, then a simple, reliable two-interval or two-sequence timer is obtained in which the two intervals may be individually adjusted. This two-interval timer, illustrated in Fig. 2, has the two intervals controlled independently by R_1 and R_2. The operation of the system is as follows: When the control switch, S_1, is opened, the voltage on the thyratron grid falls off at a rate determined by R_1C_1. As long as the voltage on C_1 is sufficiently

Fig. 1—Basic circuit of a typical electronic interval timer

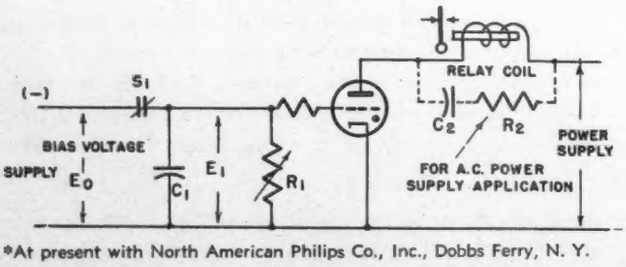
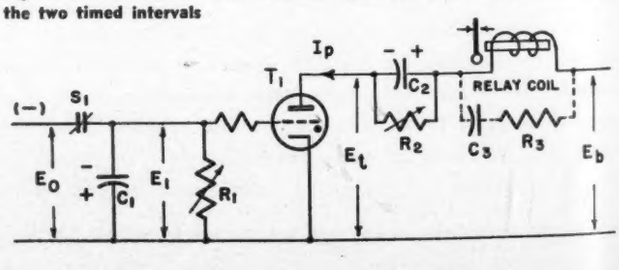


Fig. 2—The circuit of the so-called "plate-throttle" timer producing the two timed intervals



*At present with North American Philips Co., Inc., Dobbs Ferry, N. Y.

MULTI-TIME CIRCUITS

negative, the thyratron does not fire, and the relay is unenergized. When E_1 falls to a low enough value, T_1 fires, energizing the relay. This marks the end of the first timed interval, t_1, and the operation to this point is identical with that of the simple timer of Fig. 1.

The presence of C_2 alters the further operation considerably. If C_2 were not present, the current through T_1 would be constant after the tube fired, and the relay would remain pulled in. However, since unidirectional current is flowing through C_2, it charges up and reduces the current that can flow through the tube and relay, thus "throttling" the plate current. If this current ever falls to a sufficiently low value, i_d, the relay drop-out current, then the relay eventually will drop out, even though the thyratron is still conducting.

Accordingly, after the control switch is opened:

(a) relay operation is delayed for adjustable time interval, t_1, determined by (1);
(b) relay operated for adjustable time interval, t_2, determined by 5;
(c) relay out and thyratron firing, until system is reset.

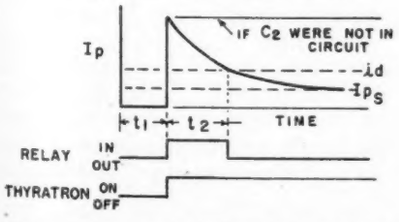


Fig. 3—The time variation curves of plate current in the double timer circuit of Fig. 2 after opening switch S_1

Fig. 3 illustrates the manner in which the plate current, I_p, flowing through the relay, varies with time, if E_b is a dc supply voltage. The corresponding relay sequence operation is also shown. The steady-state plate current, I_{ps}, is given by

$$I_{ps} = \frac{E_b - E_t}{R_2 + R_r} \qquad (2)$$

where R_r is the resistance of the relay. If I_{ps} is less than i_d, the relay drop-out current, then the relay will eventually drop out, after a period t_2. This drop out will take place if

$$R_2 > \frac{E_b - E_t}{i_d} - R_r \qquad (3)$$

This criterion is obtained by setting $I_{ps} = i_d$ in (2), and solving for R_2. If R_2 is less than the value specified in (3), then the relay will never drop out, and the control of the circuit of Fig. 2 will be identical with that of Fig. 1.

It may be shown that, neglecting the inductance of the relay,

$$I_p = \frac{E_b - E_t}{R_2 + R_r}\left[1 + \frac{R_2}{R_r}\varepsilon^{-\lambda t}\right] \qquad (4)$$

$$\text{where } \lambda = \frac{R_2 + R_r}{R_2 R_r C_2}$$

Therefore, the time required for I_p to drop to i_d, that is, the value of t_2, is determined by

$$t_2 = \frac{R_2 R_r C_2}{R_2 + R_r} \times \qquad (5)$$

$$\ln \frac{R_2}{R_r\left[\frac{i_d(R_2 + R_r)}{E_b - E_t} - 1\right]}$$

Expression (5) is complicated, but an analysis will reveal that as R_2 is decreased from ∞, the time interval t_2 is increased. The variation of I_p and t_2 for different values of R_2 is shown in Fig. 4. This increase

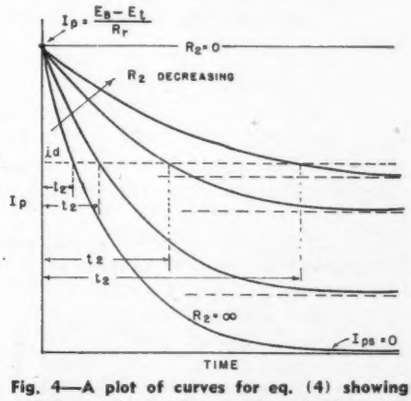


Fig. 4—A plot of curves for eq. (4) showing variations of circuit current and time with changes in R_2

of timed interval length with decrease of control resistance is the reverse of the method of control usually encountered in RC timing circuits. As R_2 is decreased from ∞ to the value given in (3), then t_2 is increased from a minimum of

$$t_2 = R_2 C_2 \ln\left[\frac{E_b - E_t}{R_r i_d}\right] \qquad (6)$$

to a maximum of $t_2 = \infty$

Further decrease of R_2 below the value given in (3) has no effect on t_2, since the relay can no longer drop out. To decrease t_2 below the minimum given by (6), C_2 can be decreased, or series resistance may be added to the relay circuit, always keeping above the pull-in current for the relay.

The source E_b in Fig. 2 can be alternating voltage, instead of a dc power supply, and the circuit will operate just as well to give a double-interval timing operation. As is common practice in relay circuits using electron tubes and ac supplies, a capacitor, C_3, is shunted across the relay coil to provide holding current during the tube-off period. The resistor R_3 is needed to limit the surge of current through the thyratron when the tube initially fires. These additional circuit elements are shown dotted in Fig. 2. It is very difficut to make exact calculations for t_2 in this case.[1] However, it has been found that using the value .636 E_{rms} for E_b in (5) gives a good approximation of t_2.

The circuit of Fig. 1 operates equally well with a hard vacuum tube or gas-filled type. However, the double-interval timer of Fig. 2 must utilize a thyratron. If a hard vacuum tube were used, then the current flowing through the relay after the R_1C_1 bias had dropped below cut-off, though not sufficient to pull in the relay, could charge up C_2 sufficiently to prevent I_p from ever reaching pull-in current. Accordingly, the relay might never operate, despite the fact that the voltage across R_1C_1 had dropped to zero.

The first timed interval, t_1, can be controlled reliably from a few cycles to three and a half minutes. For t_2 greater than five seconds, C_2 must be so large that only electrolytic capacitors can be used conveniently. The leakage resistance of the condenser must then be considered in R_2.

It is found experimentally that the second time interval is controllable reliably from 4 cycles, at 60 cps, to 10 seconds. The variation of drop-out current of the coil from operation to operation, and the instability of the leakage resistance of the electrolytic condensers, make operation below and above these values rather inaccurate. Of course,

after an extended period of disuse, the electrolytic capacitor must be reconditioned before it may be used in accurate timing circuits.

The addition of two extra sets of contacts to the relay of Fig. 2 renders the two interval timer automatically repeating, as in Fig. 5.

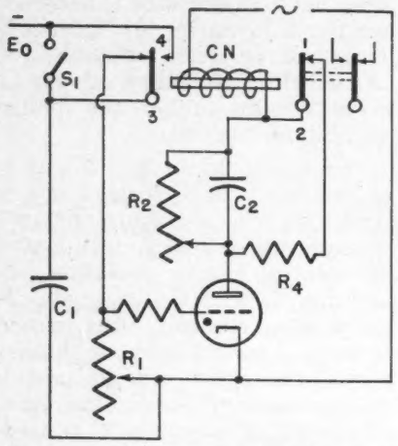


Fig. 5—A variation of the circuit Fig. 2 with the automatically repeating feature added

When operation is begun by opening switch S_1, the R_1C_1 circuit starts to discharge. After the interval t_1, the thyratron fires, energizing the relay coil and opening contacts 1,2, permitting C_2 to charge. While the relay is energized, contacts 3,4 are closed, charging up C_1. When the relay drops out after an interval t_2, due to the dropping charging current in C_2, the negative voltage is again applied to the grid of the tube by C_1, thus cutting off conduction and starting the double-interval timing over again. C_2 discharges through contacts 1,2 and resistor R_4 after the relay drops out. For this application it is preferable to use an ac voltage source to ensure extinction of the thyratron after bias is reapplied.

This automatically repeating double interval timer has been used to operate a motion picture camera every minute to take a 4-second record of a bank of meters in a test run. Detailed data could thus be obtained with reliability, as the problem of simultaneous reading of many meters during unsteady operating condition was solved. The two periods can be controlled independently, so that longer or shorter movie shots can be taken more or less frequently.

This has also been used as a "reminder" during test runs to record data every so often, from 10 seconds to 3½ minutes. The relay operated a buzzer, so that the operator would concentrate on operation of equipment or on data taking in between buzzes. When data was taken frequently, the buzzer was set for a short ring. For data taken less frequently, where the operator might have been far away from the desk, the buzzer was set for a long signal, so that the operator would be sure to hear it. There was no necessity for resetting the buzzer after each ring, or for stopping the signal manually, as the "throttling" condenser took care of it.

Further possible applications of the double interval repeating timer to industrial applications are numerous and evident. If used in conjunction with a latching type of relay, then the control cycle obtainable with this circuit is very flexible, and is limited only by the fact that the interval between each successive advancement of the latching relay contacts is constant. Varying time intervals could be obtained if desired, with the latching type of relay, by switching in different values of R_1 and R_2 with each relay advance.

Fig. 6 shows a complete schematic wiring diagram for a two-interval timer, with control available for intervals previously described. The system may be switched for single operation or repeating operation. If the 1-megohm potentiometer is turned to a low enough value, the operation is that of the ordinary electronic timer.

Double RC timing circuit

Another method of obtaining multiple interval timing with one relay and tube is to use special grid circuits. Fig. 7 illustrates the "double RC" timing circuit. Instead of the usual parallel condenser and resistor of Fig. 1 in the grid circuit, the cascaded system of Fig. 7 is used. To explain its operation, let it be assumed that the relay pulls in when the grid voltage, E_2, is greater than some positive value, e_p, because the corresponding plate current is then greater than the relay pull-in current. Then if C_2 is initially uncharged, and the operation sequence is started by throwing the multiple-contact switch S_1 (shown in the non-timing position), the voltage across the condenser C_2 will vary with time, as shown in Fig. 8, due to the

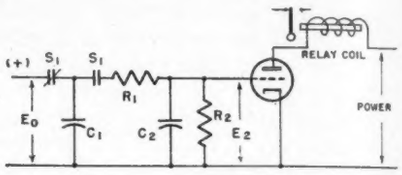
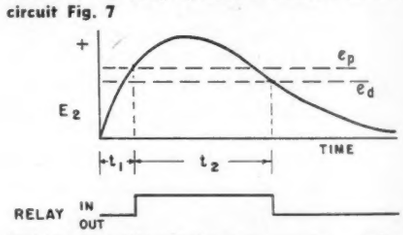


Fig. 7 (above)—A circuit for a two interval timer using two RC combinations in tandem

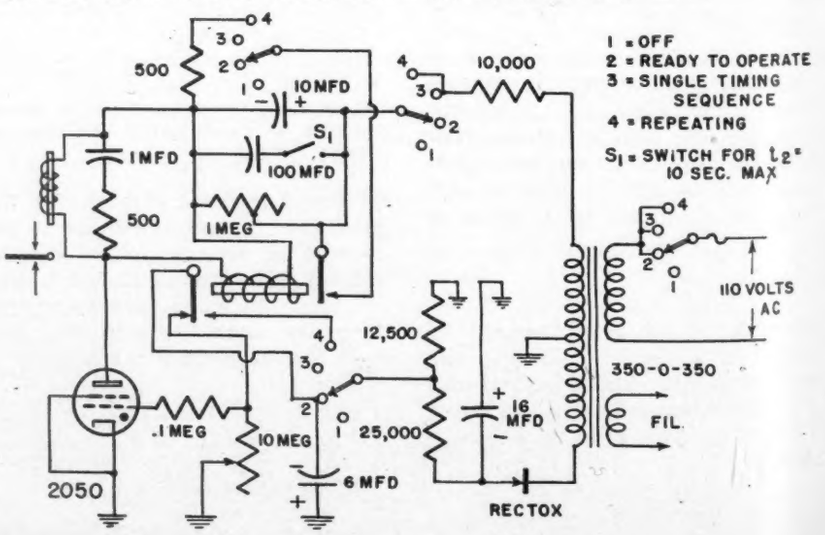
Fig. 8 (below)—The voltage variation with time and the relay operation is shown for the circuit Fig. 7



initial positive charge on C_1. The relay will pull in, and drop out as indicated, when E_2 rises above e_p, and then falls below e_d, where e_d is the grid voltage corresponding to relay drop-out plate current.

The first time interval, t_1, is the period between the operation of the actuating switch and the pull-in of the relay. It is usually short, and can be considered as a time delay before the start of the main

Fig. 6—A circuit for single or repeating two interval timers. With the constants shown, interval ranges from 1/20 second to 3 minutes and 1/15 second to 10 seconds are available



timed interval. The second time interval is the length of time the relay is in, t_2.

The voltage across C_2 is given by

$$E_2 = \frac{E_o(\varepsilon^{-\alpha_1 t} - \varepsilon^{-\alpha_2 t})}{C_2 R_1(\alpha_2 - \alpha_1)} \quad (7)$$

where E_o = initial voltage across C_1, and

$$\alpha_{1,2} = \frac{\frac{R_1 + R_2}{R_1 R_2 C_2} + \frac{1}{R_1 C_1} \mp \sqrt{\left(\frac{R_1 + R_2}{R_1 R_2 C_2} + \frac{1}{R_1 C_1}\right)^2 - \frac{4}{R_1 R_2 C_1 C_2}}}{2}$$

In (7), α_2 is greater than α_1, so that the second exponential term drops off more rapidly. This is what produces the short t_1 period, and makes the control applicable as a time delay between the actuating of the operating switch and the pull-in of the relay. From equation (7) it is apparent that variations of t_1 and t_2 cannot be made independently, as changing either R_1 or R_2 affects both values of α and therefore both intervals somewhat. However, in practical circuits, the effect of changing R_1 is to alter t_1 considerably and t_2 much less. Changing R_2 mainly controls t_2, affecting t_1 only slightly.

The two periods can also be adjusted by means of an initial charge on C_2. In that case, E_2 will vary with time as illustrated in Fig. 9. This curve is approximately

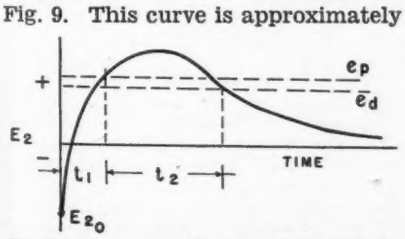


Fig. 9—A curve showing the effect of the initial voltage across C_2 on the timing intervals produced by the circuit Fig. 7

that of Fig. 8 shifted downwards an amount equal to E_{2_0} at the beginning, but subsequent characteristics of the curve are similar only if E_{2_0} is small. In general, though, there is a shifting downwards of the peak, reducing t_2 and increasing t_1, as illustrated. The two time intervals obviously cannot be adjusted independently by this method of control.

This system also can be made

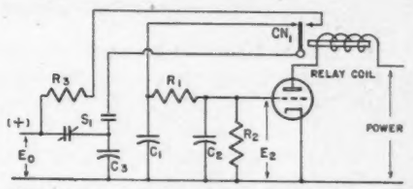


Fig. 10—A variation of Fig. 7 with the automatic repeating feature added

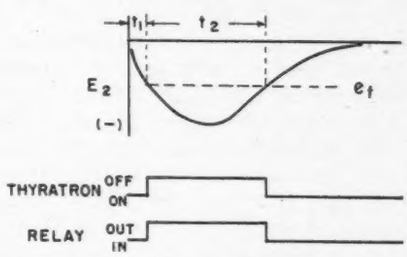


Fig. 12—The action of the circuit shown in Fig. 7 with ac operation using a gas-filled thyratron in the timing circuit

continually repeating by the proper use of a set of contacts on the relay, and the addition of an extra capacitor, C_3, in the grid circuit, as is illustrated in Fig. 10. When S_1 is operated, charging C_1 immediately from C_3 and beginning the slower charging of C_2, there is the time delay t_1 before the relay pulls in, as described for Fig. 7. When the relay is energized after E_2 rises above e_p, C_3 recharges through the relay contacts.

The removal of C_3 from the grid circuit, when the relay pulls in, decreases the rate of increase of charge on C_2, as shown in Fig. 11. As long as the relay is in, E_2 builds up to a maximum, and then falls to the relay drop-out value, e_d. When the relay drops out, C_3 is returned to the grid circuit, recharging C_2 until E_2 again is equal to pull-in voltage, e_p. From Fig. 11, it is apparent that the second off period, t_1', will be shorter than t_1, due to the charge remaining on C_2 from the previous cycle of operation. Also, t_2' will be a little greater than t_2, since the charge remaining on C_1 after the first operation cycle will permit C_2 to be recharged to a higher voltage than originally. After a few cycles, a steady state will be reached, in which subsequent t_1 periods and t_2 periods will be equal.

If e_d, the relay drop-out grid voltage, is sufficiently low, this transient period will be eliminated in one cycle of operation. Otherwise, if the transient period is undesirably long, it may be reduced considerably or eliminated, by proper selection of R_3 in Fig. 10. R_3 may be adjusted so that during t_2 interval, C_3 does not charge up to the full voltage of the source, E_o. In that event, C_2 will charge up more slowly during t_1' than it did during t_1, and t_1' can be made equal to t_1, despite the fact that $E_2 = 0$ at the beginning of t_1, and E_2 is not zero at the beginning of t_1'. Similarly, t_2' will be adjusted automatically to be nearer t_2. If the adjustment of R_3 does not compensate completely, it obviously will reduce the transient period considerably.

If a thyratron is used with tube firing at a negative grid voltage e_f, and with ac plate voltage, then even greater control flexibility is obtainable. Let the tube of Fig. 7 now be a thyratron, and let C_1 now have an initial negative charge, and the operating of the control switch connect the circuit as shown. Then the voltage on C_2 will change with time as illustrated in Fig. 12, and the operation of the relay will be on-off-on, the first "on" and the "off" being the timed intervals. With this method of operation, advantage can be taken of the circuit of Fig. 2 to give a 4-mode control cycle. If the "plate throttle" capacitor is put in the plate circuit so as to cause the relay to drop out, even though the thyratron is still firing, as previously described, then the operation sequence of the

Fig. 11—The clock of the voltage across C_2 in the circuit Fig. 10

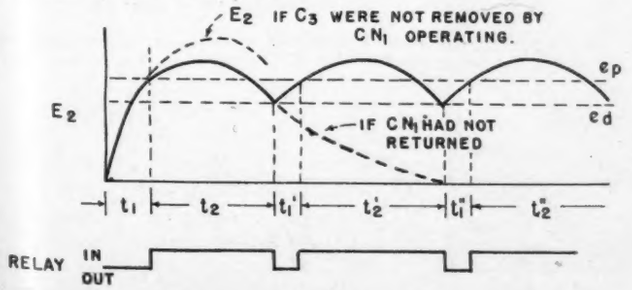
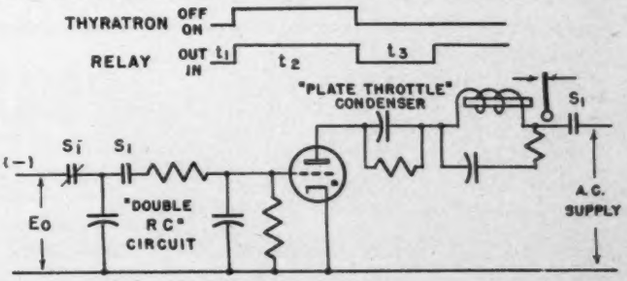


Fig. 13—A combination of the circuits Figs. 2 and 7 to produce a sequence of four operational modes. This circuit uses a thyratron tube



relay will be in-out-in-out.

This 4-mode operation circuit is illustrated in Fig. 13. It should be noted that the first dropping out of the relay may be occasioned by either E_2 becoming more negative than the tube cut-off voltage, e_f, and thus extinguishing the thyratron, or by the "plate throttle" capacitor charging up sufficiently to make the relay drop out. However, since the first interval is usually short, the former of the two is normally the cause of the first relay drop-out.

This circuit, in conjunction with a latching type relay that advances for each pull-in or drop-out of the relay hammer, could conceivably be used to time a 4-mode sequence for highly specialized applications, where convenient interval adjustment is not at a premium.

The principle of the "Double RC" circuit of Fig. 7 may be extended so as to include more branch circuits, and thus get "triple-RC" or "quadruple-RC" circuits. For example, the grid circuit of Fig. 14 will produce a control-grid voltage as illustrated in Fig. 15, resulting

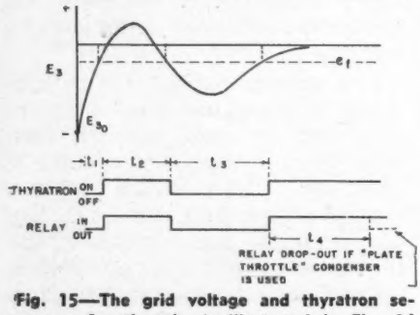


Fig. 15—The grid voltage and thyratron sequence for the circuit illustrated in Fig. 14

in off-on-off-on operation of the thyratron, if a 3-gang control switch is used, with initial voltages as shown. Adding the "plate throttle" capacitor will give a relay sequence of out-in-out-in-out. However, the computation of the exact operation of this circuit is extremely complicated, and if the first three timed periods are desired accurately, it is difficult to specify the circuit values even with elaborate trial and error computations. Varying any of the six grid circuit elements, or any of three initial voltages, changes each timed interval. Accordingly, this is not a practical circuit if the interval lengths are to be timed accurately and be independently variable. However, for a controller of a fixed process, the circuit may have merits.

"Sweep-grid" timer

A circuit possessing many unique properties is illustrated schematically in Fig. 16. It can time many intervals with a fair degree of accuracy. As a double-interval timer, it eliminates the objection to the circuit of Fig. 7, that of changing of both intervals by varying R_1 or R_2.

To understand its operation, assume that C_2 and C_3 are initially uncharged, and that C_1 has an initial negative charge. To start the timing sequence, the multiple-contact switch S_1 is operated. This fires the thyratron and operates the relay, since $E_3 = 0$. C_2 will build up a charge from C_1 at a rate determined by the values of C_1, C_2 and R_1. When E_2 is equal to the breakdown voltage E_{BD} of the neon tube, the tube will fire. As shown in Fig. 17, C_3 will now charge up to a voltage of E_{3_0}, and C_2 will fall to a voltage E_{2m} such that

$$E_{2m} = E_{30} + E_t \qquad (8)$$

where E_t is the neon tube drop. The thyratron will now be cut off and the relay will drop out and stay out, till E_3 falls below e_f, the rate of fall being determined mainly by C_3 and R_3. Accordingly, the two time intervals, t_1 and t_2, as shown in Fig. 17, may be independently controlled, the first being determined only by E_0, C_1, C_2 and R_1; the second being determined mainly by C_1, C_2, R_3 and the neon tube characteristics.

The values of t_1 and t_2 can be shown to be

$$t_1 = \frac{R_1 C_1 C_2}{C_1 + C_2} \ln \left[\frac{1}{1 - \frac{E_{BD}}{E_0} \frac{C_1 + C_2}{C_1}} \right] \qquad (9)$$

and

$$t_2 = R_3 C_3 \ln \left[\frac{E_{30}}{e_f} \right] \qquad (10)$$

E_{3_0} is determined by the fact that

$$E_{30} C_3 = (E_{BD} - E_{2m}) C_2 \qquad (11)$$

since all the charge on C_3 comes from C_2, if the discharge through T_1 is rapid enough to permit us to disregard any current flowing through R_1 during the discharge, and if the time constant $R_3 C_3$ is much greater than the discharge time through T_1. Using (8), we get

$$E_{30} C_3 = (E_{BD} - E_{30} - E_t) C_2 \qquad (12)$$

or

$$E_{30} = \frac{(E_{BD} - E_t) C_2}{C_2 + C_3} \qquad (13)$$

The solid line of Fig. 17 shows the sequence if E_0, the initial voltage on C_1, is designed so as to raise E_2 high enough to fire the neon tube only once. The relay sequence is then in-out-in, with the added possibility of in-out-in-out sequence for the relay, if the "plate

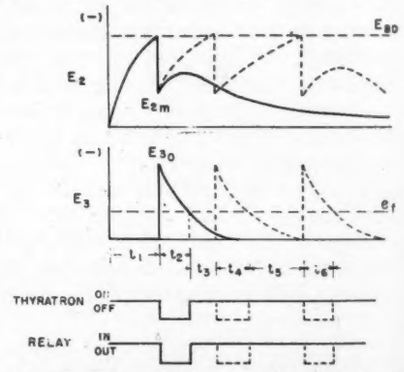


Fig. 17—The voltages across the grid circuit elements of the circuit Fig. 16. In this figure the solid line represents conditions where E_0 is large enough for only one breakdown of the neon lamp T_1. The dotted line represents the conditions where E_0 is large enough for several breakdowns of the neon tube T_1

throttle" circuit of Fig. 2 is incorporated.

However, if E_0 is high enough, then the voltage on C_2 may rise to the neon tube striking voltage several times, producing the voltages on C_2 and C_3 and the corresponding relay operation, indicated by the dotted lines in Fig. 17. As is

(*Continued on page 98*)

Fig. 14—An interval timing circuit with three RC combinations in tandem

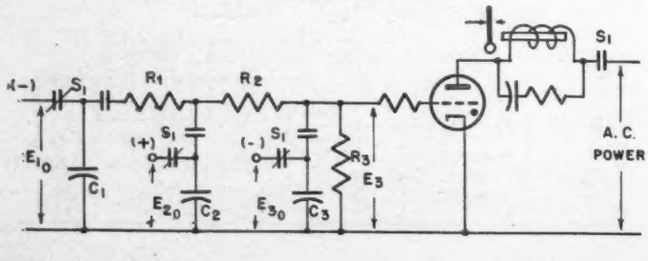
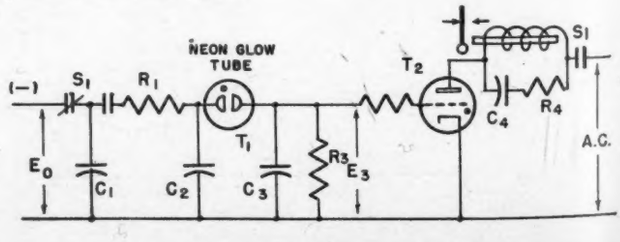


Fig. 16—A multiple interval timer with a neon glow tube incorporated in one of the timing circuits



ENGINEERED ASSEMBLY

How streamlining was applied in converting Stewart-Warner fuze plant for continuous flow operation

● A pre-war refrigerator assembly plant that was changed-over, but fast, at the beginning of the war to military production again has made a right-about face ending up as one of the largest continuous-flow production lines in the radio industry. The proximity fuze plant of Stewart-Warner in Chicago, after more than six months actual operation in the assembly of radio receivers, contains many production ideas which illustrate quite effectively typical American streamlined production methods.

The first step in reconverting Stewart-Warner's proximity fuze plant was the installation of power conveyors as the basis for the assembly of components on chasses ➤

▲ Setting up calibration and adjustment benches (60 total) where output from production lines will be calibrated

So far, four parallel radio assembly lines are in use. This permits utilizing some of the lines for extended periods for the production of popular styles, leaving others available for shorter runs where needed. Because, in a production setup of this type, a free movement of materials at all points in the assembly must be arranged for, a study of how the material flow lines are controlled at all points can be made on a floor plan layout diagram.

Incoming materials, parts and other components enter the plant at the left end of the layout shown, from an area (covering some 20,000 square feet of floor space) that provides space for a material receiving department, the incoming inspection department and for parts and process storage. From here, the components progress as needed to the fabrication benches and to sub-assembly groups, such as those used for coil winding, finishing and assembly. The units produced by all sub-assembly groups then move to the chassis assembly

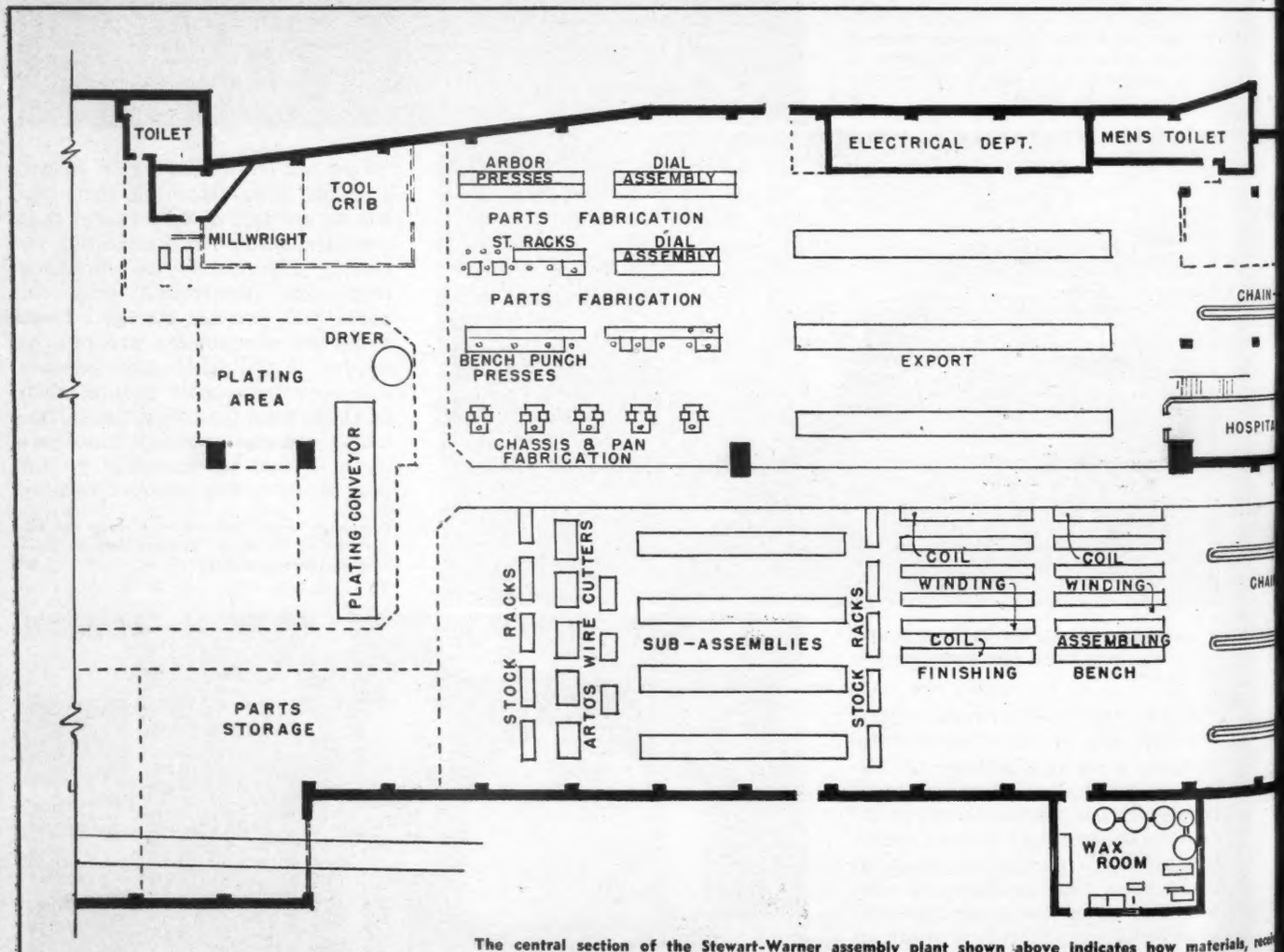
Completely assembled receivers reach the adjustment or "phasing" benches directly from lines on roller conveyors ▼

conveyors. These are U-shaped assembly lines, on both sides of which are stations for workers. The chasses, placed on wooden cradles, are moved along the line at fixed intervals of time by an automatic power drive. The assembly is completed piece-by-piece after having traversed this motorized line, which is 270 ft. long.

At each operating station around the "U" there is a bin for holding the part or component added at that particular station. Just under that bin, and right above the work area, is an air intake, through which fumes from soldering, etc., are sucked up into an exhaust system.

At the end of the "U" conveyor, the completed chassis moves to a long bench, where additional com-

The central plan in this assembly system centers around the production conveyor lines where all individual operations are broken down and separately handled by successive operators



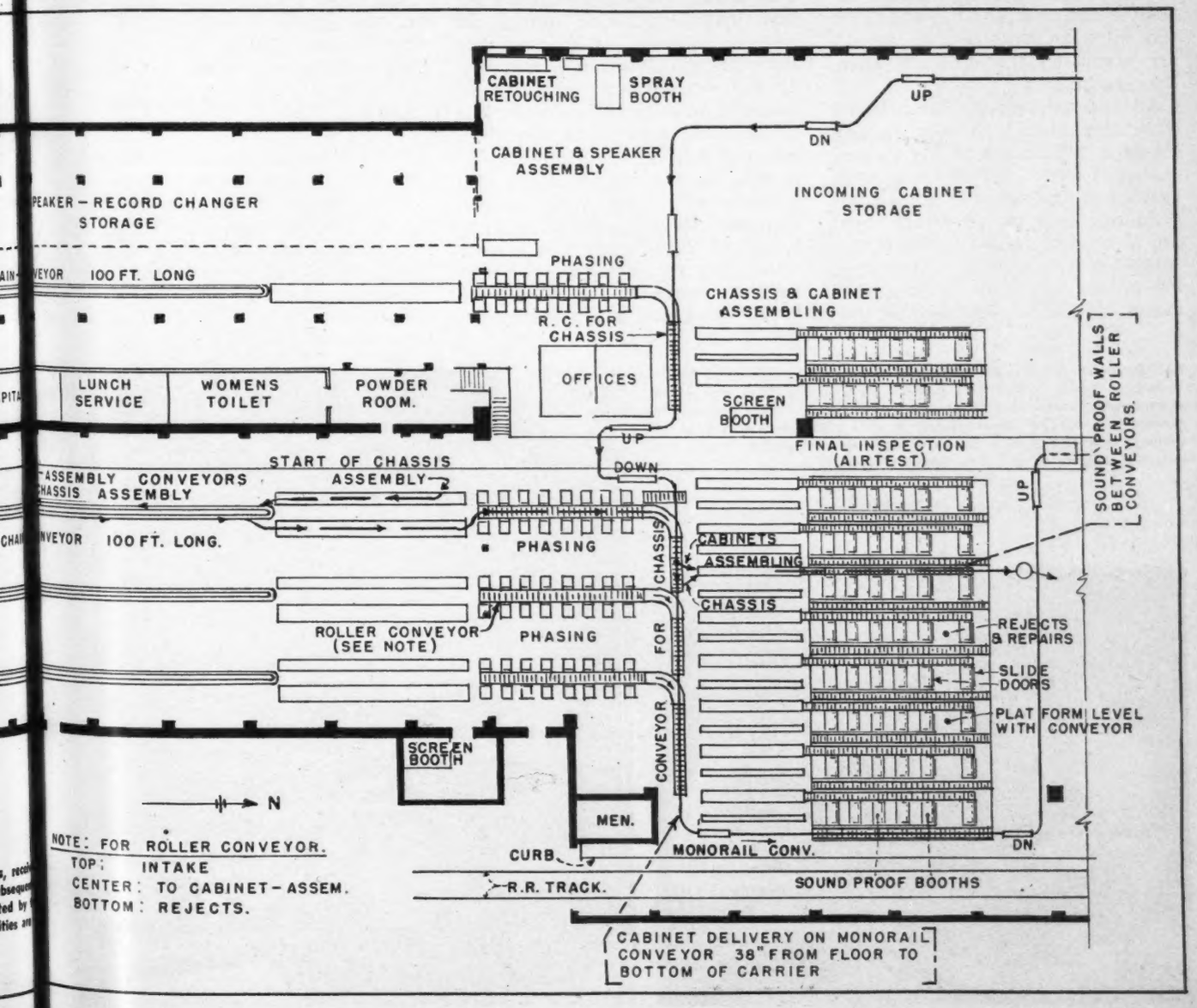
The central section of the Stewart-Warner assembly plant shown above indicates how materials, recei and inspected in the space (not shown) preceding the left-hand portion of the layout, are subsequen fabricated, assembled, adjusted, tested and shipped. Cabinet assembly and shipping is facilitated by overhead monorail conveyors routed as shown at the right. Storage, packing and shipping facilities are space beyond the right end of the section shown here

ponents are added. It then moves along a belt conveyor for a few feet and onto an inclined power-conveyor, passing to a roller conveyor to reach the so-called "phasing stations", where all necessary adjustments or calibrations are made.

There are three levels to this roller-type conveyor alongside these "phasing stations". Sets arrive on the top level. If a set is defective and cannot be tuned and calibrated properly, it is placed on the lower level by the operator, whereupon it moves back in the direction from which it came, marked for reworking. If it "passes", it is placed on the middle level where it continues on to the end of the line.

The end of the roller conveyor line is directly under the overhead conveyor line (itself 750 ft. long) on which the cabinets ride. Operators remove a chassis from the roller conveyor, and a cabinet from the overhead line, and bring the

Certain final operations and checks are made on a long steel bench before the sets are passed on to the phasing operators



Final mechanical adjustments are made on sets delivered to and taken away from the benches by roller conveyors

Jigs are used wherever possible to assist assemblers. Here chasses are held while cabinets are placed around them

two together on the steel tables or benches. The chassis is placed in its cabinet and moves on down to the end, where the now completed set is placed on another roller conveyor line.

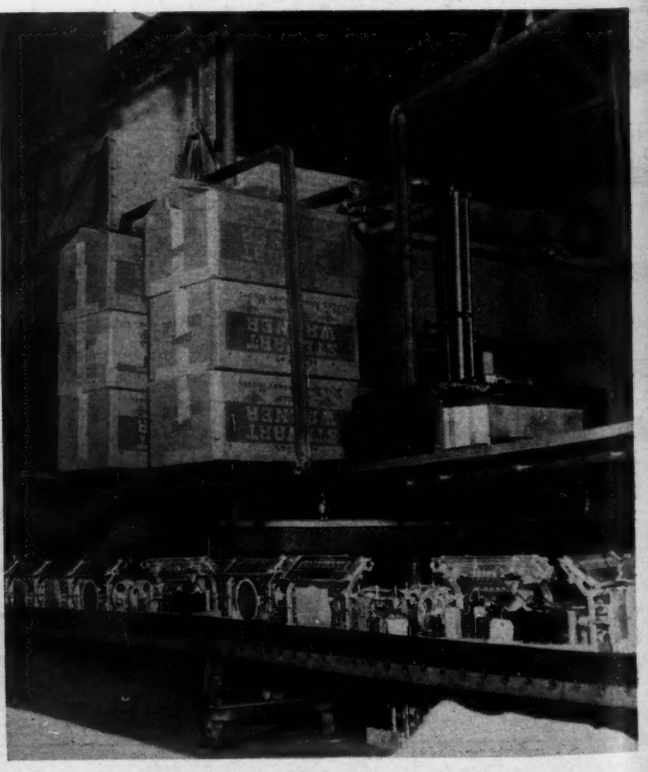
This overhead conveyor is called a "floating stockroom" because incoming cabinets (and in some cases the shipping container or carton) are placed on the conveyor when they arrive.

An unusual feature which saves congestion when large cabinets are involved, is that in some cases the cabinets arrive at the final test booth accompanied by the actual shipping container in which they are to be shipped later. When the cabinet is removed, the container is left on the overhead conveyor and moves around to a position at the end of the reception-test booths, eventually, and is then filled with a completed and tested radio set.

This last roller conveyor line moves alongside one side of a row of the sound proofed, shielded reception-test booths. There are 60 of these test booths for all lines. Here the test operator checks tuning for various stations, listens for tone performance, station selectivity, etc. If the set performs properly he places it on the roller conveyor line on the side opposite the one from which it was taken. However, if it is defective in performance, he tags it and puts it back on the original conveyor from where it is later taken off for re-working or corrections. Sets passing inspection successfully, move to the end of the "O. K." line and are removed by hand and packed into waiting shipping containers, sealed and then loaded onto handtrucks. As each truck is filled it is pushed to the railroad or the motor freight loading docks. Approximately 20,000 square ft. of additional shipping room space is at the right end of the layout shown, divided between areas devoted to the packing and the assembling of complete orders and to the shipping requirements.

To hold 5,000 console sets—one day's operation, approximately, at capacity operation—would require twenty freight cars, or 24 large-sized motor freight trailers. The total plant capacity is between 4,500 and 5,000 radio sets per day, requiring approximately 1,500 workers of all types.

Final inspection of radio-phonograph combinations preliminary to packing (below). Packing cartons are immediately available from one of the slowly-moving overhead conveyors that continually circulate between the packing and shipping departments. A view of another section of this overhead storage system is shown at right with completed chasses, cabinets and shipping cartons conveniently at hand



German night-fighter, right, against which "Tuba" jammer was used. Part of "Lichenstein" radar equipment seen on nose. Entirely new system of night-fighter radar was adopted in June, 1944, as result of successful jamming of Lichenstein. Jamming was not carried out by pulsing, but by continuous radiation. Magnetrons could not develop required power continuously, and resnatron principle was adopted. Industrial research with magnetrons continued, however, resulted in the development of magetrons of enormous power for various important frequency ranges.

ANTI-RADAR

Spoiling effectiveness of enemy equipment

Oscillator of the AN/APT-9 jammer, parts of which are shown, operates from 300 to 2500 mc, with power output of 50 kw continuously from resnatron. This power and frequency range represents tremendous advance in radio art, and engineers anticipate wide peacetime application.

"Half-Cheese" antenna is part of "Tuba" jammer. Yields a beam very sharp in the vertical plane, and relatively broad in horizontal plane; will operate over unusually wide frequency range. "Half-Cheese" is reflector, excited by waveguide and horn seen at bottom. Apparatus was installed in England; could be completely loaded in seven Army trucks when moved.

ELECTRONIC USES IN

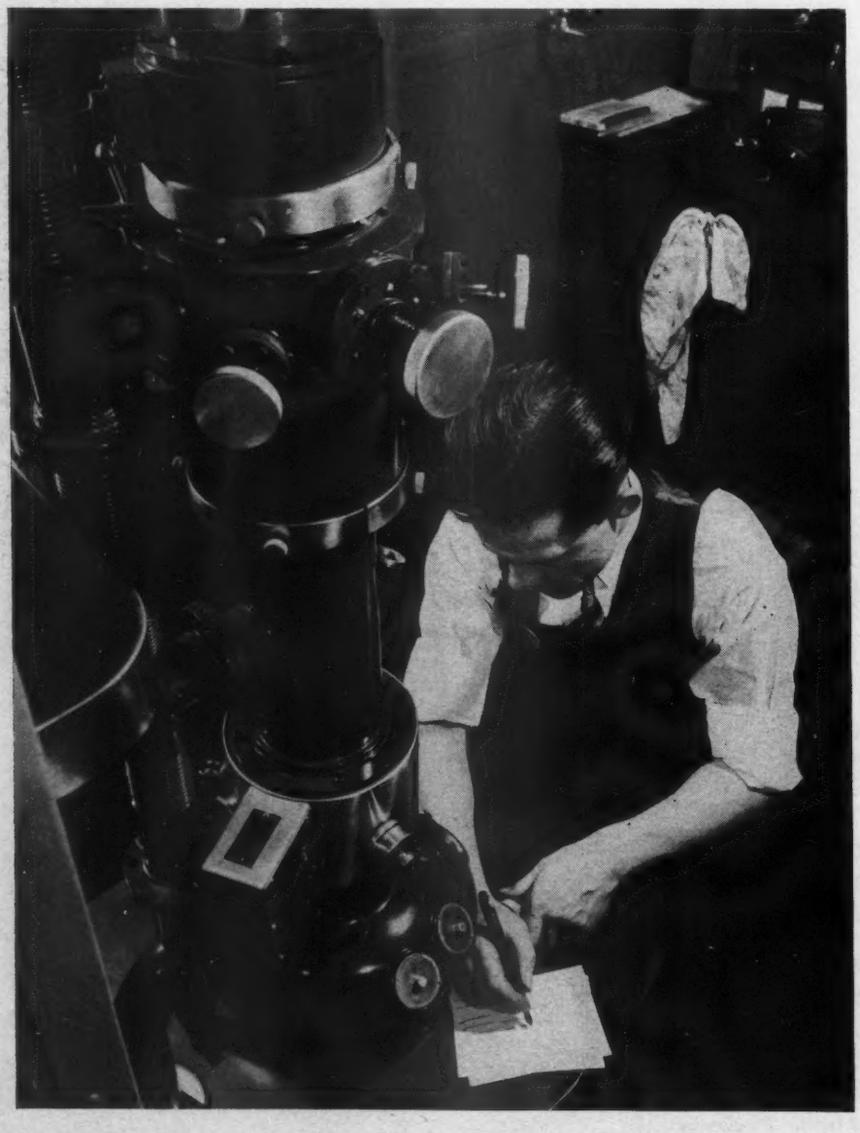
Some of the many ways in which the oil industry has learned to rely upon vacuum tube technics

Catalytic petroleum processes require rapid and accurate means of following changes in complex chemical mixtures. For these purposes, electronic devices have been extremely useful. Starting with electron microscopes and ultraviolet or infra-red spectrometers the number of devices used has steadily increased while the field of usefulness of each has expanded. The present application to the petroleum industry of some instruments in which electronics play a part are described.

• Electronic methods now have a big part in petroleum production, beginning with geophysical devices used in oil location, and electronic aids to drilling, and continuing through the manufacturing processes which utilize photo-electric spectrometers, densitometers, mass-spectrometers, and the science of electron optics as applied to electron diffraction and the electron microscope.

Sizes and shapes of particles play an important part in several petroleum fields. Full understanding of the behavior of greases, pour points of lubricating oils and activity of solid catalysts calls for making visible extremely small objects. Often sizes of the objects are beyond the resolving power of light. And even for magnifications within the range of optical microscopes, clearer images are obtained with the electron microscope, whose theoretical magnification extends to 100,000 times.

The electron microscope plays an important part by permitting identification of sizes and shapes of particles, revealing characteristics of molecular groups and in studying catalysts



Electrons can replace light waves for diffraction studies as well as for magnification. Scattered from the surface of objects, electrons yield patterns characteristic of the spacing of molecular groups on the surface of the objects. By referring to known patterns, diffraction serves as a much simpler analytical method than usual chemical means for many mixtures.

A useful application of electron diffraction has been to study surface corrosion in laboratory and plant equipment. The surface of a clean new piece of iron equipment for example will give a diffraction pattern characteristic of metallic iron. As corrosion proceeds patterns will change, and a comparison of the patterns with those obtained on various oxides of iron will reveal the type of oxidation proceeding on the metal surface. In the same way changes occuring on the surface of solid catalyst used in such processes as catalytic cracking can be studied. Deposition of extraneous material on the surface of the catalyst will be shown immediately by diffraction patterns. Thus, the kind of contamination that may occur in a catalytic process can be followed, and studies made of loss of catalyst activity in a process as it is influenced by such contamination.

Magnification by the electron microscope is helpful in studying changes in activity of catalysts as it is affected by the shape of the catalyst surface or size of the catalyst. Growth of catalyst crystal size may in some cases be associated with deterioration in catalyst activity.

PETROLEUM REFINING

Solidification of lubricating oils at their pour points is due to crystallization of wax. Pour inhibitors added to oils in small quantities prevent solidification of the oil by changing crystal structure. The way in which a pour inhibitor acts can be studied microscopically, and assist in developing new inhibitors of improved power.

In the same way that colored petroleum products absorb light of certain wavelengths when visible light is passed through them, colorless products absorb certain wavelengths of infra-red light. Wavelengths absorbed and transmitted are characteristic of the products and can serve to identify them. With the infra-red spectrometer, infra-red radiations are passed through samples of material to be analyzed, and the relative absorption and transmission of various wavelengths measured.

Spectrograph and densitometer

In the petroleum industry the infra-red spectrometer can be used for examining either liquid or gaseous substances. One big advantage of the instrument is that it requires but small amounts of samples; for liquid samples only one or two drops are needed. Principal application of the spectrometer in petroleum research is for the analysis of complex hydrocarbon mixtures.

As an oil sample is placed in the optical path of the infra-red spectrum, radiations of various wavelengths characteristic of the different compounds in the sample are absorbed. Absorption causes a drop in the amount of radiation at that wavelength and as the instrument scans through the spectrum the amount of light transmitted is picked up by a thermocouple. From the pattern of absorption corresponding to various wavelengths the composition of the sample can be determined. Infra-red spectrometry is an invaluable means of following new laboratory experimental processes and refinery operations in which distribution of isomers in the product is important.

Many materials when burned or heated to incandescence emit light of frequencies characteristic of elements in the materials. In the spectrograph, light so emitted is broken up by a diffraction grating into the emission spectrum. The spectrum is allowed to fall on a sensitized photographic film which on development contains lines and bands of varying opacity corresponding to the frequencies of the light emitted. From the location and intensity of the lines and bands in the spectrum the elements present in the material can be determined.

The densitometer is another electronic instrument used for translating the photographic image of the spectrum obtained in spectrograph into the analysis of the material. Visual inspection of the film in the densitometer equipped with a suitable scale shows the frequencies at which the lines and bands occur; and a photo-electric cell in the instrument permits opacities of lines and bands to be accurately measured. Spectra can therefore be used both for the qualitative detection of substances and for their quantitative evaluation.

Some catalystic processes are extremely sensitive to "poisoning" of catalyst through deposition of contaminants on the surface of the catalyst. In catalytic cracking where hundreds of tons of catalyst are present in a single cracking unit, even small percentage losses mean losses of tons of material daily. And in cracking, it is impossible to avoid exposing the catalyst to countless contaminating influences.

In catalytic cracking the catalyst

(*Continued on page* 105)

In oil compounding the infra-red spectrometer has become particularly valuable by reason of its ability to reveal the composition of samples through the examination of absorption patterns

TELE INTERFERENCE-

By DR. T. T. GOLDSMITH
Director of Research, Allen B. DuMont Laboratories, Passaic, N. J.

Part I—A general analysis of signal sources that may have noticeable effect on both picture and sound reception quality

(See Two-Page Chart Supplement With This Issue)

Television broadcasting is reaching substantial proportions on the permanent commercial channels assigned by the FCC between 44 and 216 megacycles. As more and more television stations go into operation, as well as services on the adjacent FM, amateur, and aviation channels, inevitable interference conditions become apparent. It is the purpose of this article to discuss some of the factors resulting in the presence of stray signals in television receivers.

Channel allocations, image frequencies, local oscillator radiation, and the frequency and field strength of other services are important considerations. Engineers of the industry and the FCC have arrived at carefully chosen allocations and equipment designs which provide service which is fairly free of interference. However, a review of the technical reasons for interference conditions that exist will assist in diagnosing and relieving the troubles.

• Many questions have arisen regarding the apparently greater interference present on new television frequency allocations. In some cases there is evidence of indirect interference, since it is possible for the picture or the sound from a second station on certain frequencies to appear faintly, as an interfering moving pattern, or as a web of diagonal lines across the pictures. For example, in New York City a receiver tuned to WCBW (new Channel 2, 54-60 mc.) may also receive a small amount of signal from WABD (new Channel 5, 76-82 mc.) This second signal comes in by way of the image frequency response, a characteristic of all superheterodyne circuits. Since this interference is only one form that can take place a systematic survey of all possibilities appears on the chart insert in this issue.

A television receiver has amplitude modulation reception conditions for the picture channel, and frequency modulation circuits for the sound channel portion. In practice it is common to use one local oscillator to beat the two incoming carriers for picture and sound, into two different intermediate frequency amplifier channels for picture and sound, respectively. Thus a television receiver is basically the same as two broadcast receivers utilizing different intermediate frequencies but having a common local oscillator.

A television channel is 6 megacycles wide and so the circuits cannot be made too selective in any case. Of course, extraneous signals appearing within any television channel will interfere with proper reception. However, in most of the interference conditions, extraneous signals arrive at the detector on frequencies outside of the transmission channel of the desired station.

Most of the existing television receivers marketed since 1940, have a sound intermediate frequency of 8.25 mc and a picture intermediate frequency of 12.75 mc. However, since the video frequency signals occupy a range of zero to well over 4 mc, the principle of vestigial signal sideband reception has been used to economize on the radio spectrum.

Dr. T. T. Goldsmith

In the receiver the intermediate frequency amplifier bandpass circuits are designed to pick up the signals at the carrier frequency at one-half sensitivity, and the upper sideband (from 0.75 mc above the carrier to 4 mc above the carrier) at full sensitivity. At 0.75 mc below the carrier, the sensitivity has dropped off to zero. The sound carrier of this channel (5) has a carrier frequency of 81.75 mc. Its frequency modulated sound signals are accepted through an intermediate frequency channel responsive to an excursion of approximately ±40 kc.

To permit specific analysis of interference possibilities a chart of receiver frequencies appears with this issue wherein are shown the major allocations from about 7 mc through 280 mc (horizontal scale). Vertically the information is divided into three major groups dealing with:

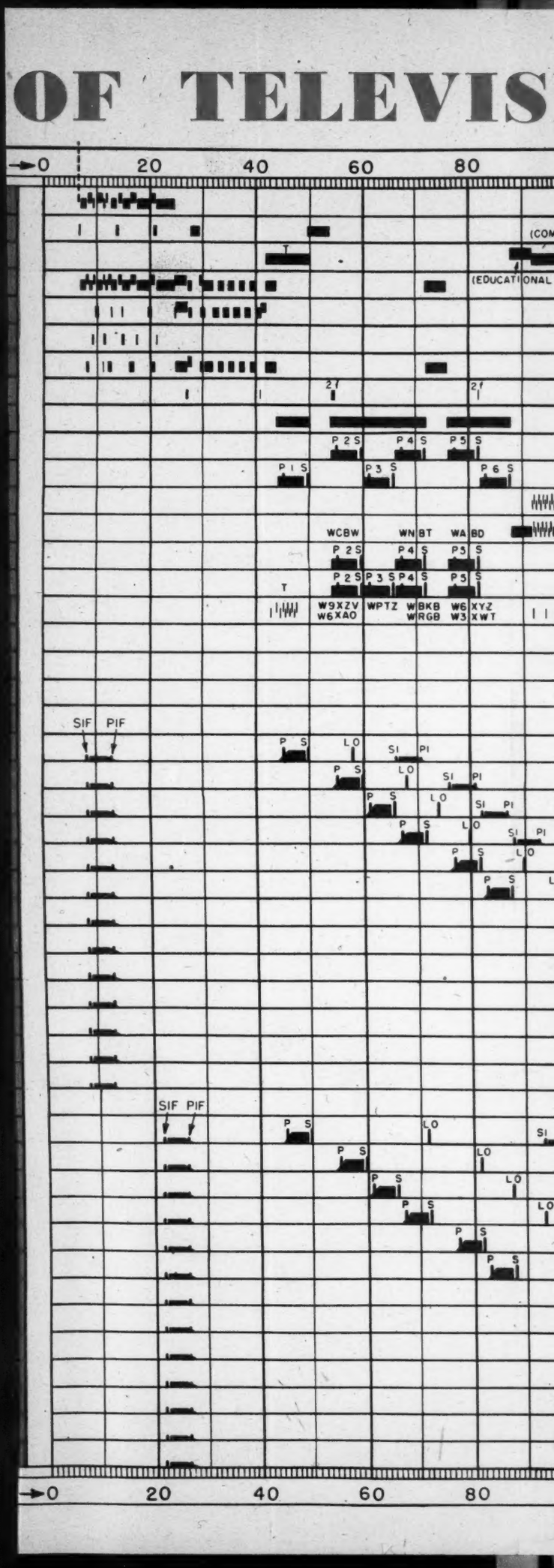
(1) transmitters, (2) old television receivers having the 8.25 mc sound IF, and (3) the new television receivers with 21.9 mc sound IF.

In the chart information the frequencies allocated to the nine major groups are shown by box entries. Detailed information concerning television and FM assignments, particularly for New York city, are shown on the chart in lines 10 through 16. Conditions in other areas can be determined with equal facility, since spaces have been left in the chart, wherein block entries may be added for other particular areas.

SOURCES OF TELEVISION

LINE			FREQUENCY IN MEGACYCLES → 0	20	40	60	80	100	120
	1	SERVICE ALLOCATIONS	AERONAUTICAL						
	2		AMATEUR						
	3		FREQ. MODULATION						
	4		FIXED						
	5		GOVERNMENT						
	6		INT'L BROADCAST						
	7		MOBILE						
	8		SCIENTIFIC, IND., & MED.						
	9		TELEVISION						
TRANSMITTERS	10		TELEVISION, NEW YORK CITY						
	11		OTHER TELEVISION						
	12		COMM. FM NEW YORK CITY						
	13		OTHER FM						
	14		ACTIVE TELEVISION, N.Y.C.						
	15		" TELE., ELSEWHERE						
	16		" FM N.Y.C.						
	17								
	18								
	19								
	20								
OLD RECEIVERS 9.25mc SOUND IF	21		CHANNEL 1 44-50 mc						
	22		" 2 54-60 "						
	23		" 3 60-66 "						
	24		" 4 66-72 "						
	25		" 5 76-82 "						
	26		" 6 82-88 "						
	27		" 7 174-180 "						
	28		" 8 180-186 "						
	29		" 9 186-192 "						
	30		" 10 192-198 "						
	31		" 11 198-204 "						
	32		" 12 204-210 "						
	33		" 13 210-216 "						
	34								
NEW RECEIVERS 21.9mc SOUND IF	35		CHANNEL 1 44-50 mc						
	36		" 2 54-60 "						
	37		" 3 60-66 "						
	38		" 4 66-72 "						
	39		" 5 76-82 "						
	40		" 6 82-88 "						
	41		" 7 174-180 "						
	42		" 8 180-186 "						
	43		" 9 186-192 "						
	44		" 10 192-198 "						
	45		" 11 198-204 "						
	46		" 12 204-210 "						
	47		" 13 210-216 "						

FREQUENCY IN MEGACYCLES → 0 20 40 60 80 100 120


OF TELEVIS
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P 3 S
P 6 S
WCBW
WN BT
WA BD
P 2 S
P 4 S
P 5 S
T
P 2 S
P 3 S
P 4 S
P 5 S
W9XZV
W6XAO
WPTZ
W BKB
WRGB
W6 XYZ
W3 XWT
SIF
PIF
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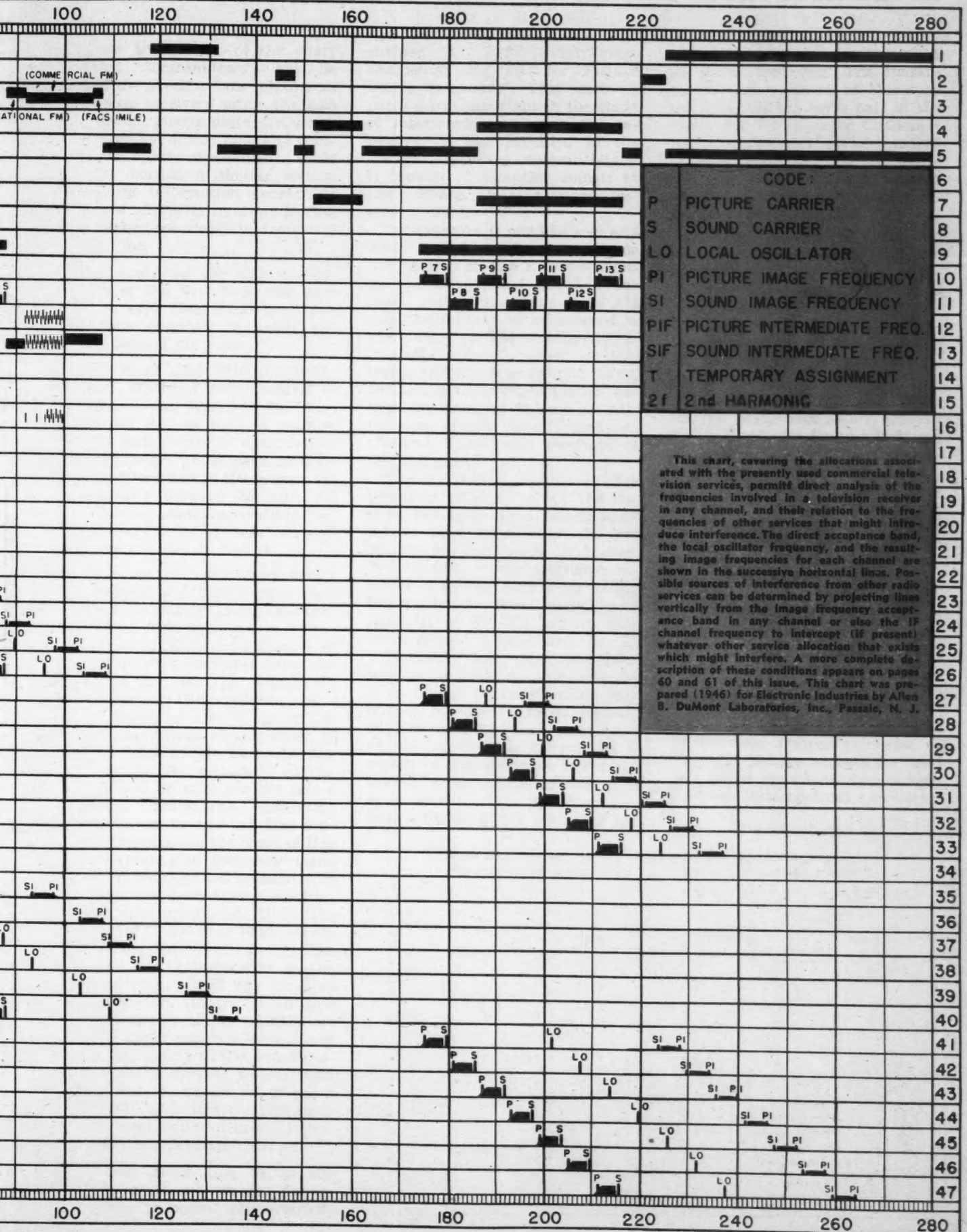
LO
SI
PI
SIF
PIF
P S
LO
SI
0
20
40
60
80

SION INTERFERENCE



This chart, covering the allocations associated with the presently used commercial television services, permits direct analysis of the frequencies involved in a television receiver in any channel, and their relation to the frequencies of other services that might introduce interference. The direct acceptance band, the local oscillator frequency, and the resulting image frequencies for each channel are shown in the successive horizontal lines. Possible sources of interference from other radio services can be determined by projecting lines vertically from the image frequency acceptance band in any channel or else the IF channel frequency to intercept (if present) whatever other service allocation that exists which might interfere. A more complete description of these conditions appears on pages 60 and 61 of this issue. This chart was prepared (1946) for Electronic Industries by Allen B. DuMont Laboratories, Inc., Passaic, N. J.

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ENGINEERING PROBLEM

Below the section of the chart entitled "Transmitters" will be found the specific data relating to television receivers using the 8.25 mc sound intermediate frequency for reception of any of the 13 commercial television channels, while at the bottom a similar section providing information concerning the new television receivers having the higher intermediate frequency of 21.9 mc.

For analyzing the data an example of the New York city area will be used. Here there are three television channels in active use for broadcast purposes:

WCBW of CBS (Channel 2-54-60 mc), WNBC of NBC (Channel 4-66-72 mc) and WABD of Du Mont (Channel 5-76-82 mc). A number of FM stations are in operation in the temporary assignment between 40 and 50 mc and in the permanent assignment between 88 and 108 mc. These television stations are shown on line 14 of the chart and the FM stations on line 15.

Thus we can study by direct comparison the interference conditions prevailing upon an "old" television receiver tuned to Channel 4, as illustrated on line 24 of the chart, with that of a newer design, on line 38. The former receiver has an IF acceptance sensitivity illustrated near 10 mc on the chart and signals of this order, if strong, might "ride through" the RF circuits. The picture IF carrier is centered at 12.75 mc but has a sideband acceptance extending down almost to 8.25 mc. The vertical dimension on the chart of this IF acceptance is purposely made small to indicate less sensitivity at IF than the desired good sensitivity on the receiver at RF in the vicinity of 70 mc. Near 70 mc we see the receiver sound circuit is tuned to 71.75 mc corresponding to the carrier frequency of the Channel 4 transmitter illustrated on line 14. The picture carrier at 67.25 mc has an upper sideband acceptance extending nearly to the sound carrier. Looking farther to the right along line 24, we see at 80 mc a line (LO) indicating the frequency of the local oscillator in the superheterodyne television receiver.

Farther along line 24 in the vicinity of 90 mc, we see an acceptance response characteristic entitled "S.I." for "Sound Image Frequency" and "P.I." for "Picture Image Frequency". This range is particularly important in the study of interference, although the rereceiver is less sensitive to the "image" frequency. Nevertheless it is capable of accepting signals at the antenna in this image frequency band.

For example, if one looks up and down the chart along the 90 mc line he sees on line 3 that stations on the Educational FM and the lower part of the commercial FM assignments may be intercepted in locations where FM stations of considerable strength exist on this image frequency acceptance band. In fact, the FM experimental stations operating at 92.1 mc actually produce strong interference on Channel 4 in many receivers of the old type.

The RF tuned circuits of the television receiver accept the desired television signal much more readily than they accept the FM signals on the image frequency. Nevertheless, if the television receiver is located very close to the FM transmitter, then the high field strength of the FM station may cause serious interference.

The first and most successful method to overcome this difficulty is to choose on intermediate frequency for the television receiver so that the image acceptance band of the receiver is thrown in a region of the spectrum where relatively weak signals are currently produced. This approach has been adopted in the design of the new television receivers, using 21.9 mc sound frequency. The characteristics of receivers of this type are listed on the lower part of the chart. For example, for Channel 4 the image channel has been moved up to a region near 120 mc where channels for relatively low powered aeronautical and government services have been allocated.

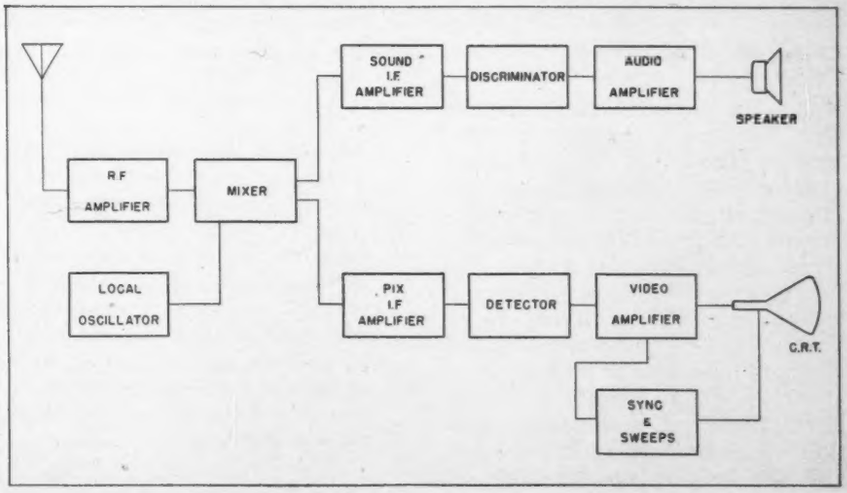
Another approach to a solution of the image problem (and the only practical one for existing receivers) is to provide additional tuned circuit attenuation for signals arriving on the image frequency. Details of these remedies are treated more fully in a later paragraph.

Referring again to line 24 in the IF acceptance band between 8 and 14 mc. are found allocations to mobile services. These are relatively weak transmitters in general, although a police car coming close to a receiver might introduce a high field strength producing momentary interference. We also find (line 6) international broadcast assignments around 8½ and 11½ mc, wherein are some stations which transmit 200 kw of signal strong enough to ride straight through the RF and mixer circuits of the television receiver and produce visible interference in the picture channel of the television set.

The change to the new receiver intermediate frequency is seen to push the picture acceptance band to a region reasonably free of high powered international broadcast

(*Continued on page* 108)

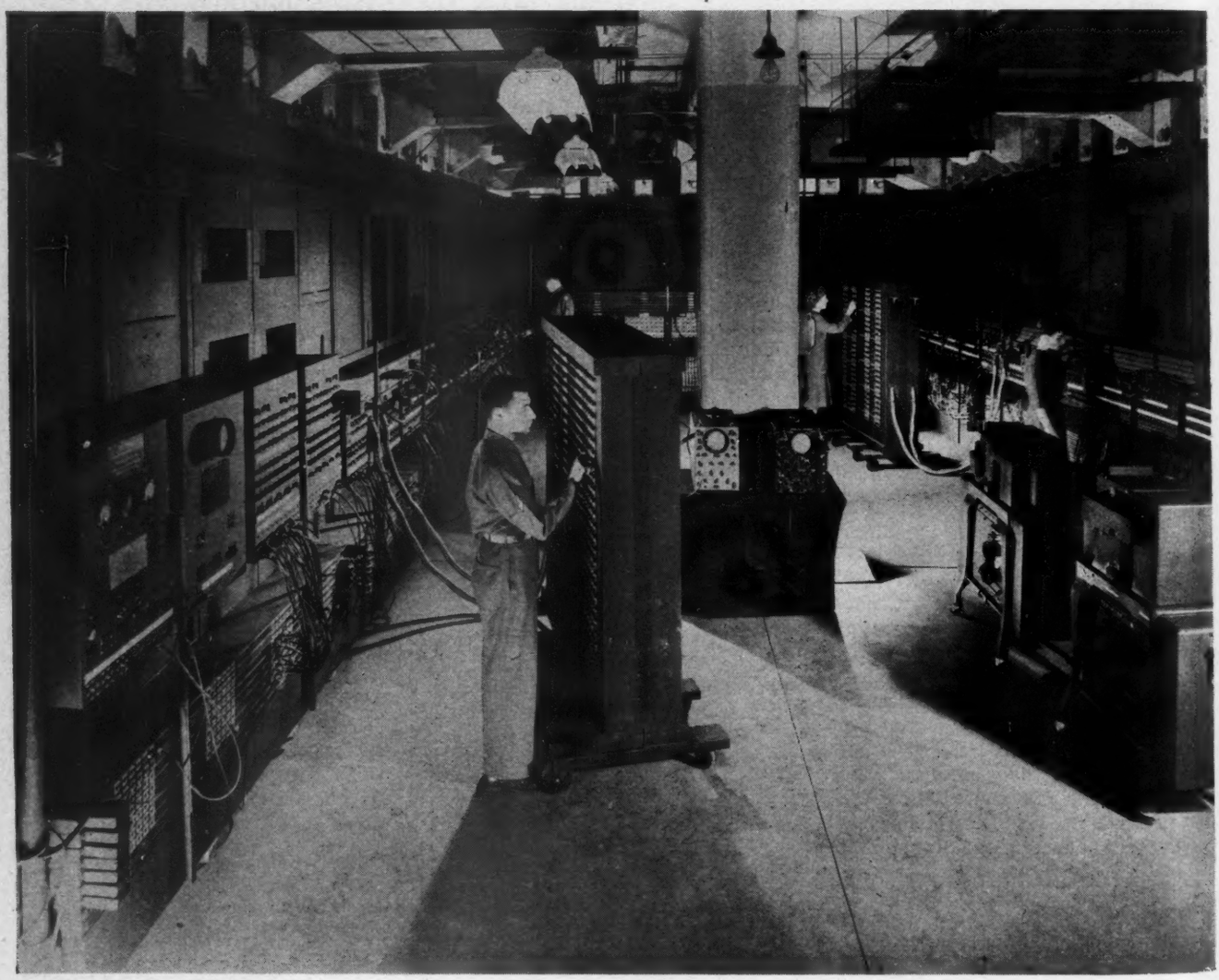
Single local oscillator and two IF systems having a specified frequency difference permits sight and sound to be separated in television receiver.



SUPER ELECTRONIC

By DR. ARTHUR W. BURKS
Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia

ENIAC, requiring 18,000 vacuum tubes, was developed at the request of the Ordnance Dept. to perform 5,000 computations a second



General view of the Electronic Numerical Integrator and Computing machine in process of being prepared to solve a hydrodynamical problem

The ENIAC (Electronic Numerical Integrator and Computer) is the first all electronic computing machine to be built. While other computing devices use electronic equipment, the actual computing in these machines is done mechanically or electro-mechanically, not electronically. It is the purpose of this article to explain how the ENIAC solves mathematical problems electronically.

• As the name, ENIAC, implies, this machine is capable of integrating (and also of differentiating) electronically. Though electronic circuits which integrate and differentiate (such as RC and RL circuits) are known, the ENIAC does not make use of them. Rather, it integrates and differentiates by reducing these processes to numerical computations, that is, to a series of the elementary arithmetic operations of addition, subtraction, multiplication, division, square-rooting, and the looking up of values of the various functions required.

Thus the ENIAC consists of twenty adders (called Accumulators because they both store and add numbers), a high-speed multiplier, a divider and square-rooter, and three function tables, in addition to control units for directing the arithmetical operations (cycling unit, initiating unit, and master programmer) and units for getting numbers into and out of the machine (constant transmitter and printer); see Fig. 1 for a plan view of the machine. Though one of the

COMPUTING MACHINE

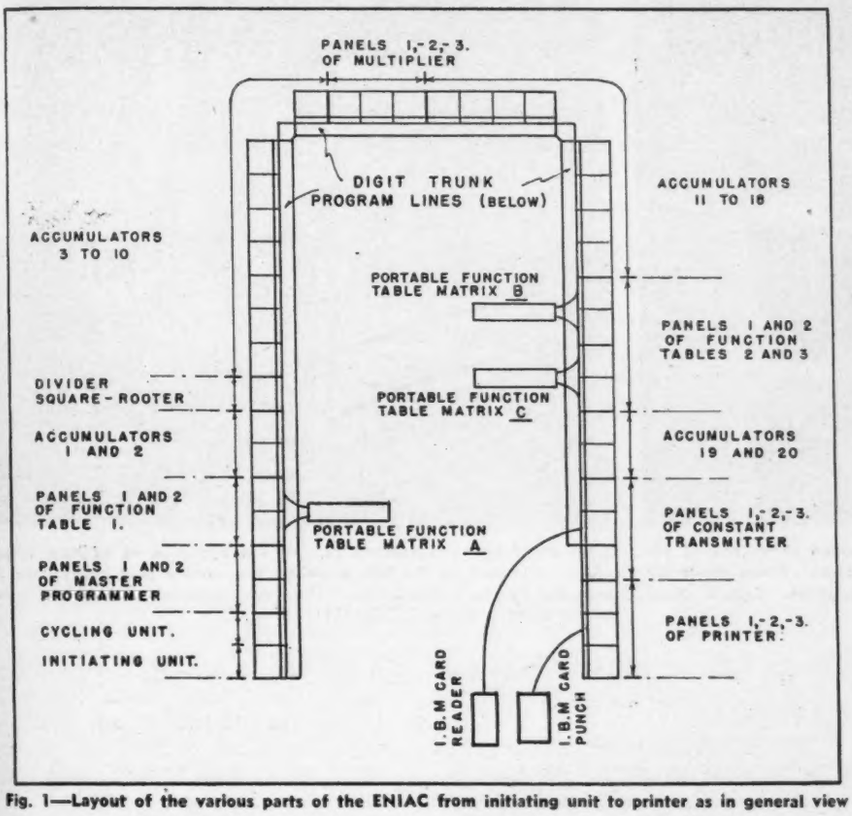

PANELS 1,-2,-3. OF MULTIPLIER
DIGIT TRUNK
PROGRAM LINES (BELOW)
ACCUMULATORS 11 TO 18
ACCUMULATORS 3 TO 10
PORTABLE FUNCTION TABLE MATRIX B
PANELS 1 AND 2 OF FUNCTION TABLES 2 AND 3
DIVIDER SQUARE-ROOTER
PORTABLE FUNCTION TABLE MATRIX C
ACCUMULATORS 1 AND 2
ACCUMULATORS 19 AND 20
PANELS 1 AND 2 OF FUNCTION TABLE 1.
PORTABLE FUNCTION TABLE MATRIX A
PANELS 1,-2,-3. OF CONSTANT TRANSMITTER
PANELS 1 AND 2 OF MASTER PROGRAMMER
CYCLING UNIT.
INITIATING UNIT.
PANELS 1,-2,-3. OF PRINTER
I.B.M CARD READER
I.B.M CARD PUNCH

Fig. 1—Layout of the various parts of the ENIAC from initiating unit to printer as in general view

primary tasks of the ENIAC is to solve differential equations, the fact that it does this by computing makes it a much more general and versatile device than a machine which does only that one job (such as a differential analyzer).

It is an important feature of the ENIAC that amplitude-sensitive circuits are not the electronic means of achieving these arithmetic and control operations. Numbers are not represented by the magnitudes of voltages, but by the presence or absence of electrical signals on wires or by vacuum tubes being either off or on. Similarly, numbers are not added in circuits which add voltages, but are added by means of electronic counters which count pulses representing the numbers.

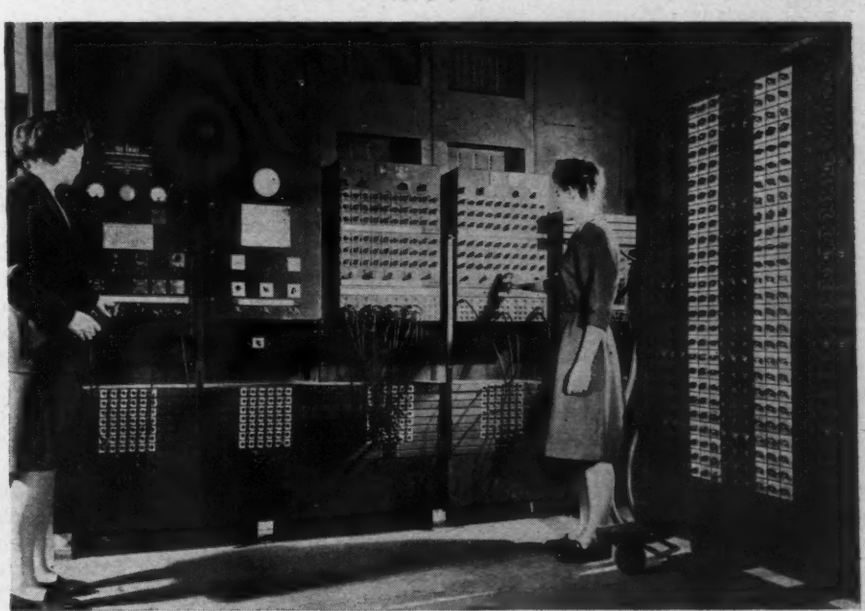
All tubes in the ENIAC are operated as switches (i.e., either "on" or "off") and hence the effects of the variation of resistors, changes in tube currents, etc., do not affect the accuracy of the computations, provided, of course, that these variations are kept within certain broad limits. The accuracy of ENIAC computations is not limited by the accuracy of the circuit components, but only by the fact that the numbers it can handle must not exceed twenty digits.

Thus the ENIAC is a digital or discrete-variable computer in contrast to a continuous-variable machine such as the differential analyzer (in which quantities are represented by the positions of continuously varying shafts). That large-scale computations by other than electronic means will soon be out of date is shown by the fact that the ENIAC is 1000 times faster than any other existing digital machine!

It is impossible in this article to describe in detail a machine with 18,000 vacuum tubes, 6,000 switches, 5,000 terminals, using 80 dc voltages, etc. On the other hand, a general description of the machine will not explain how the computation is done electronically. So let us take a very simple differential equation ($\frac{dy}{dx} = y$), show how it can be solved by a series of additions, multiplications, etc., set it up on the ENIAC (see Fig. 3, which shows only the ENIAC equipment used in the problem), and describe how some typical operations are performed electronically (see Fig. 7).

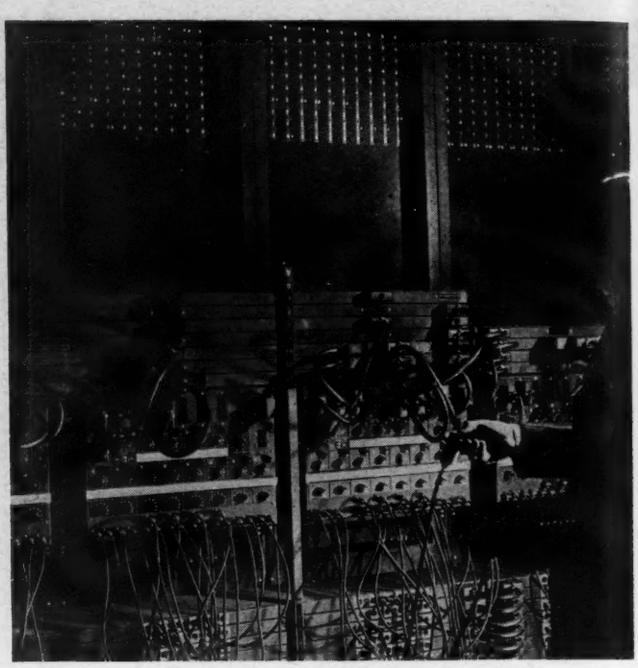
The solution to $\frac{dy}{dx} = y$ is, of course, $y = K e^x$. But the ENIAC, even though it is an "electronic brain," cannot give an answer in this form. What it can do is compute a numerical solution for any given set of initial conditions. Thus if it is told that when x is zero y is

Two Ordnance Department technicians arranging program settings on the Master Programmer



[1]The ENIAC was designed and built at the Moore School of Electrical Engineering for the Ordnance Department of the United States Army. Major H. H. Goldstine was the Ordnance Department representative; Dr. J. G. Brainerd was the administrative supervisor; Mr. J. P. Eckert was the chief engineer; and Dr. J. W. Mauchly was consulting engineer.

Initiating and cycling units of ENIAC. 'scope screen shows one of the fundamental electrical signals transmitted to all units. Neons above the 'scope correspond to the 20 different parts of addition. Each of these parts represents 1/100,000 of a second



Close-up of two accumulators showing the operation of addition taking place. The unit on the left is storing the number plus 1203762893 as indicated by the lighted neons. The next accumulator, which will transmit its number, is storing 30333311112

one ($x_0 = 0$, $y_0 = 1$), it can compute the values of y for various values of x (for example, for x = .01, .02, ..., .99, 1.00). It always gives numerical answers to mathematical problems. This is, however, the form in which they are useful to engineering and empirical science.

To solve a differential equation numerically, we first replace the derivative $\left(\frac{dy}{dx}\right)$ by the ratio of increments $\left(\frac{\Delta y}{\Delta x}\right)$. This gives $\frac{\Delta y}{\Delta x} = y$, or $\Delta y = y\Delta x$, which tells us how to compute the increase in y for a given change in x. Calling the initial values x_0 and y_0 and the next values x_1 and y_1, we have

$x_1 = x_0 + \Delta x \quad (x_1 = 0 + .01 = .01)$

and

$\Delta y_0 = y_0 \Delta x \quad (\Delta y_0 = 1 \times .01 = .01)$

and hence

$$y_1 = y_0 + \Delta y_0 = y_0 + y_0 \Delta x$$
$$(y_1 = 1 + .01 = 1.01).$$

By means of the same formulas the next values (x_2 and y_2) can be computed from x_1 and y_1:

$x_2 = x_1 + \Delta x \quad (x_2 = .01 + .01 = .02)$

$$y_2 = y_1 + \Delta y_1 = y_1 + y_1 \Delta x$$
$$(y_2 = 1.01 + 1.01 \times .01 = 1.0201).$$

See Fig. 2. This process can be repeated indefinitely (after ten steps we have $x_{10} = 0.1$, $y_{10} = 1.1046$, or $e^{0.1} = 1.1046$). The computation of 100 values of y and x (x = .01, .02, ..., .99, 1.00) would give a table of e^x such as is found in the *Handbook of Chemistry and Physics* and would take the ENIAC 0.06 seconds (not counting the time for printing the answer).

Three accumulators are required for this computation. An accumulator is both an electronic storage or memory device and an electronic adder. It can store a ten-digit number with sign and can be combined with another accumulator so that the pair can hold a twenty-digit number with sign. It can transmit the number held in the form of groups of pulses or receive groups of pulses representing a number and add that number to its contents in 1/5000 second. Counter circuits are used for the electronic storage and addition.

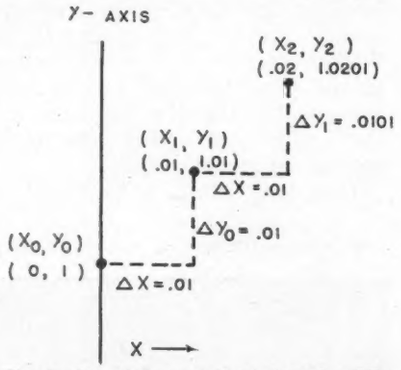


Fig. 2—Steps in numerical solution of a differential equation

Each accumulator contains ten decade counters (one for each digit). A decade counter is made up of ten flip-flops or Eccles-Jordan trigger circuits. Fig. 4 shows a flip-flop in one of its two states, called the "reset" state, i.e., with tube #1 on and tube #2 off. When a negative pulse is received on the "set" input, tube #1 will cease conducting and cause tube #2 to go on. Thus the flip-flop "remembers" that it has received a pulse on the "set" input and indicates this fact by raising the voltage on the static output line. A negative pulse on the "reset" input will send it back to its original state and cause the static output voltage to drop.

The ten flip-flops of a decade counter are so inter-connected that at any given time one flip-flop is in the "set" state and all others are in the "reset" state, and so arranged that when a pulse is received on a common input that flip-flop will "reset" and cause the next one to be "set." Thus if the #3 flip-flop is "set" the counter registers the digit three. When a pulse is received on the counter input, the #3 flip-flop will be "reset" and in so doing will "set" the #4 flip-flop so that the counter registers four (that is, 3 + 1 = 4).

The ten static output wires of the flip-flops of a counter indicate the number held. These wires are used to operate neon bulbs mounted on the front of the accumulator which enable one to read the number held and to transmit numbers statically to the high-speed multiplier and the printer.

The transmission of a number from one accumulator to another is

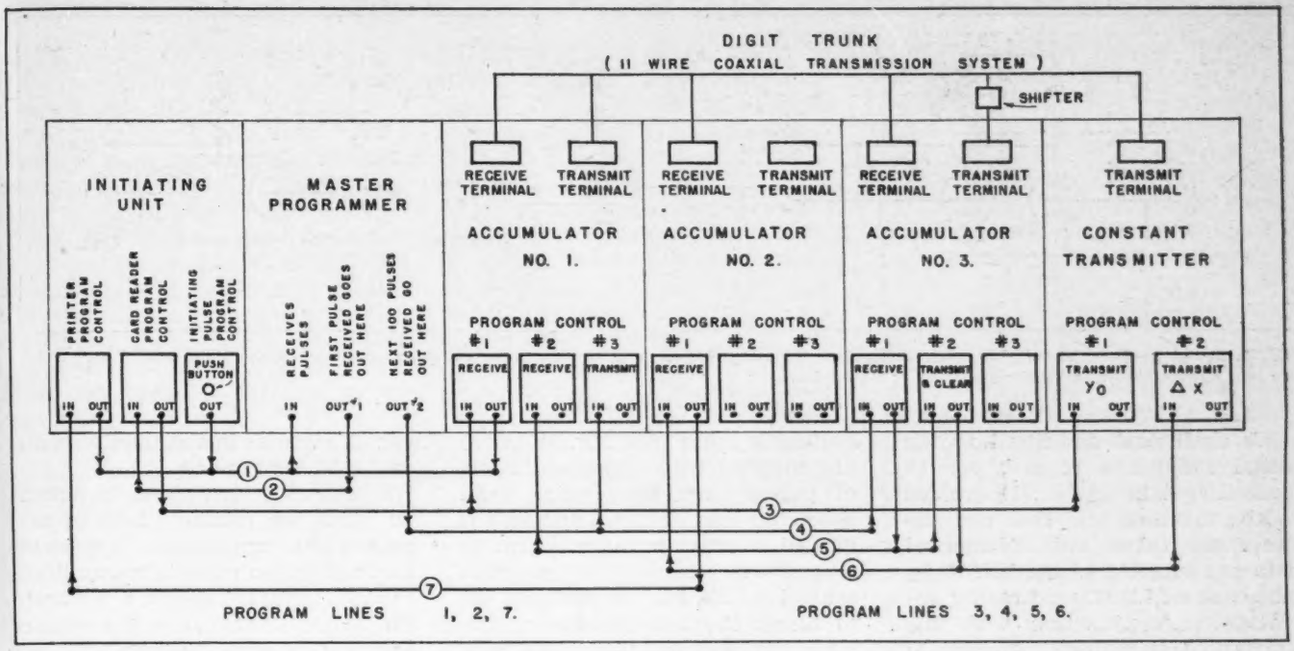


Fig. 3—Interconnection of units required to solve the differential equation $\frac{dy}{dx} = y$. This uses only a very small part of the ENIAC

done dynamically, that is, by means of groups of pulses. If accumulators 1 and 2 hold y_1 (1.0100 00000), one can produce y_2 (1.0201 00000) in accumulator 1 by causing accumulator 3 to transmit to it, shifting its number over two places to the right (so as to multiply by $\Delta x = .01$). This multiplication is done by a shifter which shifts the wires coming out of accumulator 3 over two places before connecting them to the digit trunk. Both accumulators are instructed to operate at the same time.

Since accumulator 3 is told to transmit, it will produce groups of electrical pulses (each pulse lasting about two microseconds) to represent each of the digits and the sign held in its counters. These groups of pulses will come out of the transmit terminal and go over the eleven-wire digit trunk to the receive terminal of accumulator 1. The exact method by means of which the static representation of a number in a counter is converted to pulse form is too complicated to be described here. Suffice it to say that the pulses are derived from a central source (called the cycling unit) which supplies standard timed signals to all ENIAC units.

The pulses for each digit go over a separate wire; this enables all the digits of a number to be transmitted simultaneously, accounting for the rapid addition of two numbers in the ENIAC. Since the number transmitted (after shifting) is 0.0101 00000, one pulse will go over the third wire from the left and one pulse over the fifth wire from the left ("0" being represented by no pulses). These pulses will go to the receive terminals of all the accumulators; but since only accumulator 1 has been instructed to receive, they will be passed into the decade counters of only this accumulator. The third counter from the left holds one; it will receive one pulse and change to two. The fifth counter from the left holds zero; it will receive one pulse and change to one.

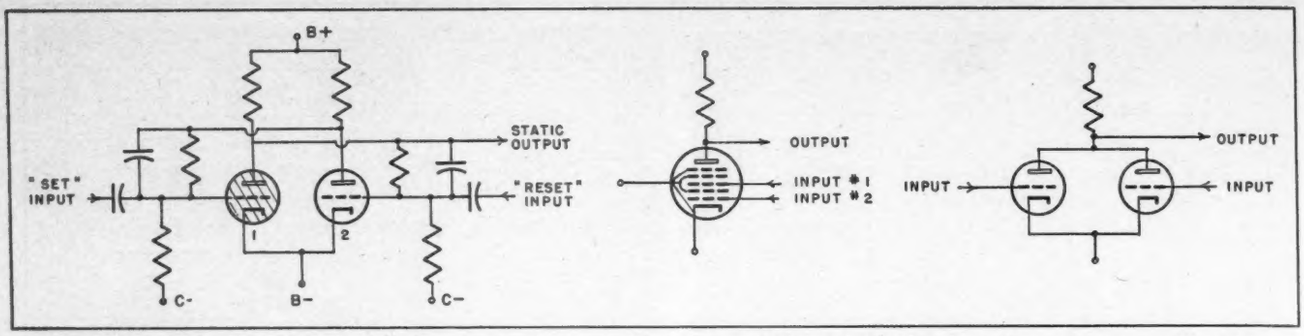
When two numbers are added together there will, in general, be some carry-overs. Since all digits are transmitted simultaneously, these must be remembered until all possible pulses have been received. This is done by means of a flip-flop which is "set" when the counter goes from nine to zero. At the proper time the cycling unit sends out signals which cause the carry-over to take place.

The necessity to allow time for carry-overs and also for circuits to be set up at various other places is the reason why twenty pulse times are required for a complete addition to take place, even though nine pulses are sufficient to represent the largest decimal digit. The cycling unit gives out pulses at a basic rate of 100,000 per second; hence an addition time is 200 microseconds, or 1/5000 second. Subtraction is accomplished in the same length of time by means of a system of complements.

The accumulator circuits which we have been describing handle the numbers in a problem and hence are called numerical circuits. Other circuits are needed to tell the numerical circuits when to operate and what operations to perform (transmission, reception, etc.). These are called programming or control circuits. In Fig. 3 the program controls of the various units are represented by boxes, with the terminals for receiving and transmitting pulses shown, and with the instructions for the operation (which are actually set up on switches) written in.

The programming of the operation described above (adding the contents of accumulator 3 to those of accumulator 1 and clearing accumulator 3) is controlled by the #2 program control of each accumulator. When it is time for this operation to be performed, an electrical "program" pulse is sent to the input terminal of each program control (over program line 5). Each program control then directs its accumulator to do the operations set up on the switches of the program control; the manner in which it does this will be described later.

After the operation is completed, a program pulse is emitted from the output terminal. Since the operations of both accumulators are synchronized by means of the electrical signals from the cycling unit, these output pulses come at the same time; hence only one need be used to inaugurate the next operation of the sequence. In this case, it goes via program line 6 to cause Δx to be added to x.



Figs. 4, 5 and 6—Show, at left, the basic Eccles-Jordan flip-flop trigger circuit, a one tube switching circuit representing the word "and" and a two tube buffing circuit having the properties of the word "or"

We shall next describe how the initial conditions ($x_0 = 0$, $y_0 = 1$) and other data ($\Delta x = .01$) are fed to the machine and how the answers are taken out. Numerical data are supplied to the ENIAC by means of an I.B.M. card reader operating in conjunction with the constant transmitter. A card is prepared with holes in it to represent the numbers to be fed to the ENIAC and placed in the card reader. Each card holds eight ten-digit numbers. Whenever a program pulse is sent to the card reader program control, it causes this card to be passed under electrical contacts and the information to be transferred to relays in the constant transmitter, an operation requiring about one-half second.

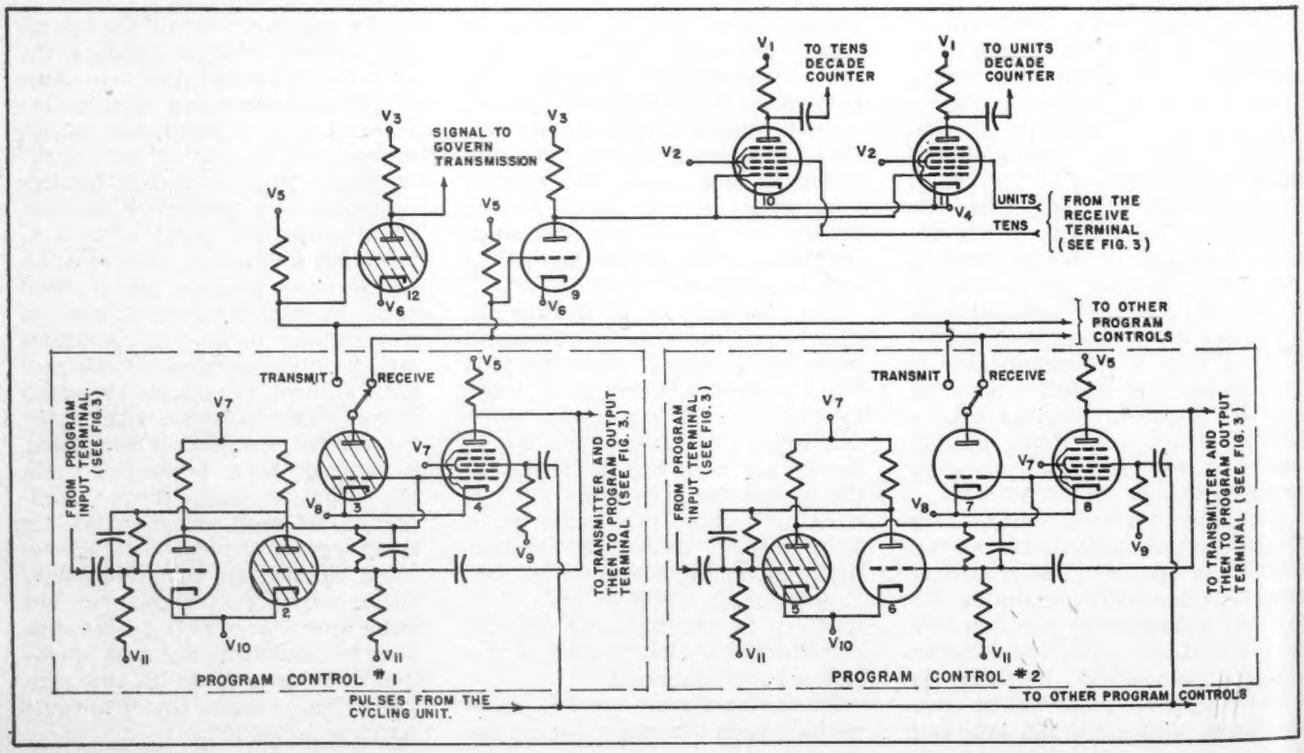
These relays in turn activate switching tubes (See Fig. 5) which are supplied with approporate sets of pulses from the cycling unit. Whenever one of these numbers is needed, a program pulse is sent to a constant transmitter program control which has its switches set to direct the transmission of the given number, and the pulses from the cycling unit are electronically switched onto the digit trunk.

This method of feeding numbers to the ENIAC is, of course, electro-mechanical rather than electronic. The ENIAC is nevertheless a completely electronic computer, since the computation is done exclusively by electronic means. Human beings express numbers by mechanical motions, so there must be some connection to the mechanical world in any computer. The ENIAC printer is likewise electro-mechanical. It operates in conjunction with an I.B.M. card punch.

Whenever it is desired to punch on cards the numbers held in accumulators, computation is stopped and a program pulse is transmitted to the printer program control. The static outputs from the decade counters of eight accumulators go to the printer, where vacuum tubes set up relays which in turn cause the card to be punched with the numbers held in the accumulators. This is a relatively slow operation, requiring about 0.6 seconds. After the cards are punched, they are placed in another machine which prints the answers on paper.

We are now able to see what is involved in the solution of $\frac{dy}{dx} = y$ for one hundred values of x (x =

Fig. 7—A typical ENIAC circuit illustrating the action of program controls #1 and #2 of accumulator #1. Program control #1 has just received a negative pulse by which it directs accumulator #1 to receive


TO TENS DECADE COUNTER
TO UNITS DECADE COUNTER
SIGNAL TO GOVERN TRANSMISSION
UNITS
TENS
FROM THE RECEIVE TERMINAL (SEE FIG. 3)
TO OTHER PROGRAM CONTROLS
TRANSMIT
RECEIVE
FROM PROGRAM INPUT TERMINAL (SEE FIG. 3)
TO TRANSMITTER AND THEN TO PROGRAM OUTPUT TERMINAL (SEE FIG. 3)
PROGRAM CONTROL #1
PROGRAM CONTROL #2
PULSES FROM THE CYCLING UNIT.
TO OTHER PROGRAM CONTROLS

.01, .02, ..., .99, 1.00). The ENIAC must first read a card (containing $y_0 = 1$, $\Delta x = .01$) and transmit y_0 to accumulator 1. It must then transmit y_0 to accumulator 3 and back to accumulator 1, shifting it over two places so as to multiply by Δx; transmit Δx from the constant transmitter to accumulator 2; and finally tell the printer to punch a card with the numbers in accumulators 1 and 2 (y_1 and x_1). This last sequence is to be repeated 100 times and then the machine is to stop.

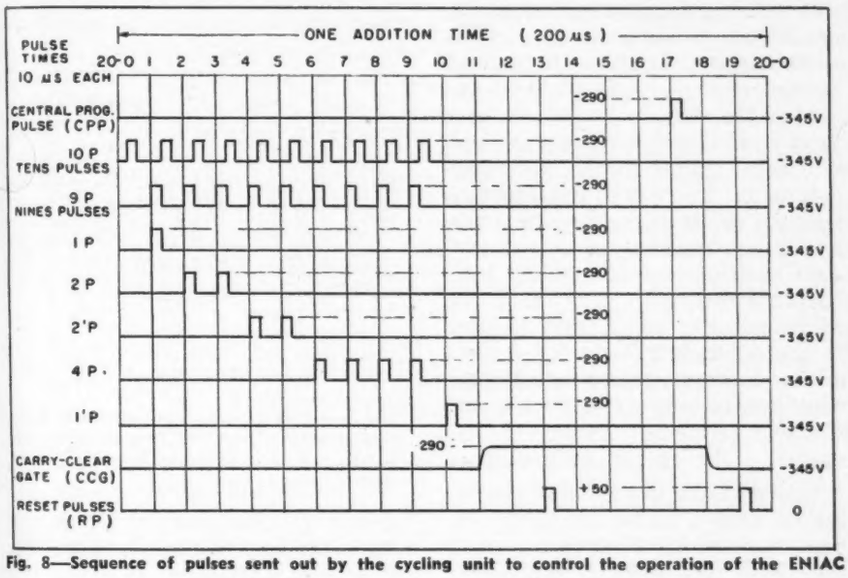


Fig. 8—Sequence of pulses sent out by the cycling unit to control the operation of the ENIAC

The problem is started when the operator pushes the button on the initiating pulse program control. A pulse is then given out which goes to the master programmer which handles the overall control of the sequences of operations set up on program controls. The master programmer is here arranged to transmit the first pulse it receives over line 2 to cause the initial conditions to be read from the punched card and transmitted to accumulator 1. After this sequence of two operations is finished, a pulse is transmitted from program control 1 of accumulator 1 back over program line 1 to the master programmer. This time it is sent out of output 2 to program line 4, causing the ENIAC to compute x_1 and y_1 from x_0 and y_0 and to print them.

When this is finished, a program pulse is transmitted from the output of the printer program control back to the master programmer over line 1. Again the master programmer sends it out of output 2 so that x_2 and y_2 will be computed and printed. This process is repeated 100 times and then the ENIAC stops. Thus the ENIAC is an automatically sequenced computer; once it is set up to do a problem and started, it will do the complete job without further direction.

Let us now consider how the ENIAC does these automatically sequenced computing operations electronically. The circuits of the ENIAC are for the most part compounded out of five kinds of circuits, each of which is quite simple. These are: (1) flip-flops, used for electronic storage; (2) counters, used for electronic storage and adding; (3) switching circuits, used for electronic switching; (4) buffing circuits, used for electronic isolation of channels in one direction but not the other; and (5) inverting circuits, employing normally conducting tubes merely to reverse polarity.

A switching circuit (Fig. 5) uses a multi-grid tube (6L7's, 6SA7's, etc.) with two inputs and one output; it will give out a negative plate signal only when it receives positive signals on both input #1 and input #2 (and is thus an electronic representation of the word "and").

A buffing circuit (Fig. 6) uses two or more tubes (6SN7's, 6L6's, 6V6's, etc.) connected together with a common load resistor to form a circuit with the properties of the word "or." The grids of all tubes are normally biased to cut-off, so a positive input signal to any tube will produce a negative output signal (which will not, because of the buffing action, affect any of the other inputs).

Fig. 7 shows how a typical ENIAC circuit is compounded out of these basic circuits. It illustrates the action of program controls 1 and 2 of accumulator 1, both of which direct the accumulator to receive (but at different times). The circuit is shown after program control 1 has received a negative program pulse telling it to direct accumulator 1 to receive. The fact that it has received the program pulse is remembered by the flip-flop which stays in the "set" position during the time the number is being received. This flip-flop turns on the buffer (tube #3) which turns off the inverter (tube #9). The action of a buffer is required here because the same circuit of tubes #9, 10, and 11 is used when program control 2 is directing the reception of a number. That is, control 1, or control 2, or any other control with a switch set to "receive" must be able to direct the accumulator to receive a number, and each at a different time. Tube #9 turns on the switches (tubes #10, 11) which connect two lines of the digit trunk to the decade counters. It is in this way that accumulator 1 is programmed to received y_0 from the constant transmitter.

After the operation has been completed, the program control must emit a program pulse which will go to direct the next operation in the problem. When the flip-flop is set, it switches on tube #4, which receives a pulse from the cycling unit at the end of every addition time. This pulse then passes through tube #4, "resets" the flip-flop, and goes out the program output terminal to stimulate the next operation. Later on in the problem, program control 2 is used in the same way to cause accumulator 1 to receive a number from accumulator 3.

We have now completed our description of how the ENIAC solves $\frac{dy}{dx} = y$. The actual setup of the problem is accomplished by manually interconnecting the program controls and digit terminals as shown in Fig. 3 and setting the switches according to the information written in the boxes. It should be remembered, however, that this problem uses so little of the total ENIAC equipment that it is, in actual fact, too simple for the ENIAC to bother with. It does not use, for instance, two of the important arithmetic units of the ENIAC: the high-speed multiplier and the function table.

(*Continued on page 96*)

CBS TELE ANTENNA

By ORVILLE J. SATHER
Television Engineer, Columbia Broadcasting System, New York

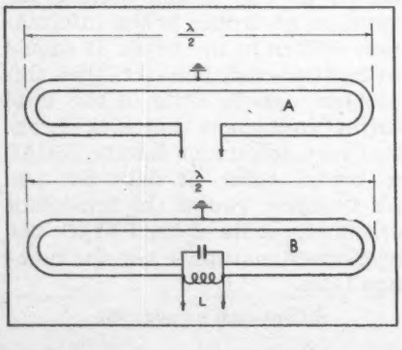
Design and constructional details of folded dipole video radiator for operating frequency of 51.25 megacycles

• The CBS black and white television transmitter in New York is located on the 74th floor of the Chrysler Building. Because of the configuration of the tower, special antenna had to be designed, since the top of the spire is inaccessible for mounting any type of conventional video radiator. The carrier frequency is 51.25 mc.

When the original installation was made in 1939, single half-wave doublet or dipole radiators one inch in diameter were projected out of each of the four sides of the tower, approximately 1000 ft. above sea level. They were spaced one-quarter wavelength from the building, and all dipoles were fed in phase, producing a uniform circular radiation pattern. The input resistance of each antenna was approximately 70 ohms at resonance; this was changed through two quarter-wave transformer sections to 280 ohms—the impedance of each pair of coaxial lines driving the antennas. The original dipoles, however, were insufficiently broad, and the reactance was too great, with the result that high frequencies were attenuated and distortion and reflections were introduced into the picture.

During the war, no attempt was made to improve the antenna system; however, in the spring of 1945 extensive tests were undertaken to determine what type of antennas could best be substituted. Initial measurements and calculations indicated that a single dipole of any reasonable size could not be used because of the high reactance slope. A conical dipole had better characteristics, but it was not practical because of its size, and the problem of heating the elements to prevent ice from forming would have been too involved. (The air in the Chrysler tower above the 75th floor is heated to 230°F. during a sleet storm; however, this does not prevent ice from forming on the antennas.)

Fig. 1—A, typical folded dipole schematic, not compensated, and B, showing compensation



Element diameter

Very encouraging results were obtained with a half-wave folded dipole antenna of the type shown in Fig. 1-A. Its several parameters were varied in order to obtain the proper resistance over the widest band possible, with the minimum positive reactance slope. It was found that varying the spacing between longitudinal elements did not have a great effect upon the impedance characteristics. However, as the diameter was increased, the resistance curve flattened with frequency variation, and the reactance slope decreased.

As an example, using an antenna 8 ft. long having a nominal spacing of 4 in., with 1¼ in. diameter elements, the positive reactance slope at resonance was 40 ohms per megacycle, while with 1¾ in. diameter elements, the slope was 33 ohms per mc. Although there was a definite advantage in using the larger diameter from the standpoint of optimum impedance, it added materially to the weight and to the difficulty of heating; for this reason 1¼ in. elements were selected as the best compromise for the new WCBW antennas. Typical measured impedance characteristics for such an uncompensated antenna are shown in Fig. 2.

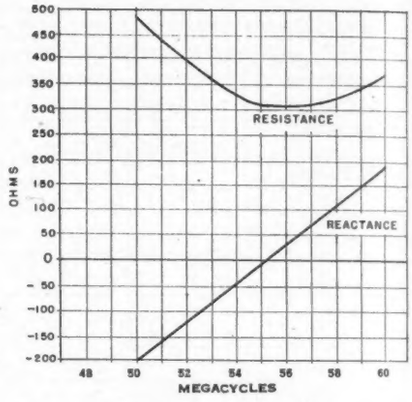
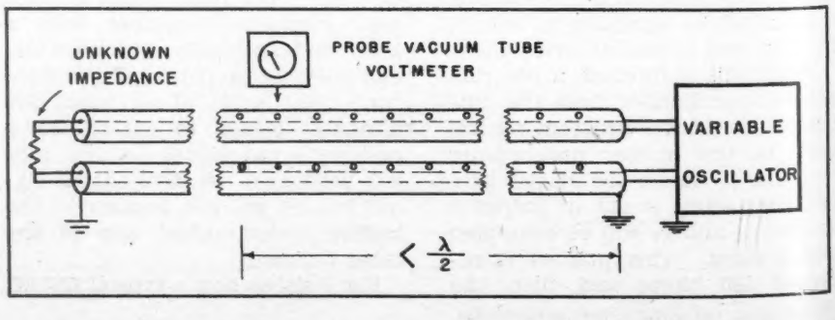


Fig. 2—Impedance of folded dipole as measured at antenna terminals (not compensated). Length 7 ft. 5 in., element diameter 1¼ in., spacing 5 in.

The method used to measure the impedance may be of interest. The antenna was connected to two accurately designed air dielectric 70-ohm coaxial transmission lines containing holes spaced 6 in. apart for the insertion of a tuned vacuum tube voltmeter probe. A push-pull

Fig. 3—Impedance measuring assembly showing probe access holes in the measuring lines



variable rf oscillator was connected to the inner conductors of the measuring lines. The measurements were made with the antenna extending out of an opening on the 76th floor of the Chrysler Building; since it was then impossible to measure voltages near the load, 70-ohm transmission lines of known length were inserted between the dipole and the measuring lines. A diagram of the assembly is shown in Fig. 3.

Standing wave voltage readings were taken on both lines using a capacity coupled probe voltmeter; from this data the relative minimum and maximum voltages were plotted and determined, and the minimum voltage point was located. Calculations were based on the formula

$$Z_L = Z_K \frac{1-\left(\frac{1-Q}{1+Q}\right)^2 - j2\left(\frac{1-Q}{1+Q}\right)\sin\theta}{1+\left(\frac{1-Q}{1+Q}\right)^2 + 2\left(\frac{1-Q}{1+Q}\right)\cos 2\theta}$$

where Z_L = load impedance

Z_K = impedance of measuring line

$Q = \frac{E\ min}{E\ max}$

θ = electrical degrees from load to point of minimum voltage.

Since the load was in series with the two measuring lines, it was necessary to calculate the impedance termination for each line and add the two to get the antenna impedance, because it was nearly impossible to balance the test setup perfectly. Calculations were simplified by using a radio transmission line calculator,[1] from which the impedance was read directly after determining the standing wave ratio and the location of the minimum voltage point.[2]

When the reactance of an antenna has a straight line positive slope which goes through zero it can be compensated over the range $\pm 2JX < R$, where the antenna impedance $Z_L = R \pm JX$. This is done by adding a parallel tuned circuit across the antenna terminals and utilizing the negative reactance slope of the network which is tuned to the resonant frequency of the antenna. The equivalent electrical circuit is shown in Fig. 1-B.

Since there is a definite relation between L and C, arbitrary values may be assigned to them and the impedance measured at several points; by this method the approximate values of L and C can be quickly determined.

Since insulating supports were required for the WCBW antennas, the capacity of the insulators was used as part of the compensation. Values of L and C for the WCBW antennas were approximately 35 microhenries and 19 micromicrofarads. The antenna terminals and compensating network were mounted within a cast aluminum head to which the ground point of the dipole was secured.

The average resistance of the compensated folded dipole was approximately 330 ohms; since 140-ohm transmission lines were used to drive the antenna, two quarter-wave coaxial transformer sections of 162 ohms and 148 ohms were used in each line between the dipole and the transmission line junction in order to match impedances.

Fig. 4-A shows the compensated antenna impedance as measured at the antenna terminals, and Fig. 4-B shows the impedance as measured at the input to the transformer sections. The antennas were fabricated from seamless steel tubing with 1/16 in. wall thickness; they were cadmium plated after bending. Heater wire for de-icing was brought into each antenna through a conduit attached to the ground point of the dipole. Fig. 5 is a top view of an antenna in place, and Fig. 6 is a view of the Chrysler tower showing the location of the audio and video antennas.

(1) Available from the Emeloid Co., Inc., Arlington, N. J.
(2) See "An Improved Transmission Line Calculator" by Phillip H. Smith, p. 130, Electronics, Jan. 1944.

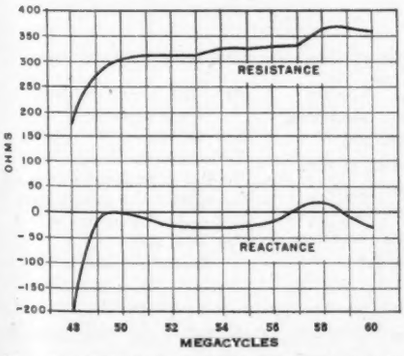


Fig. 4A—Folded dipole antenna impedance as measured at antenna terminals

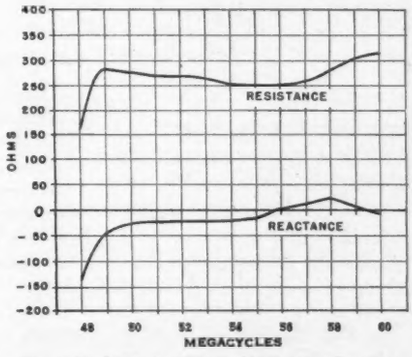
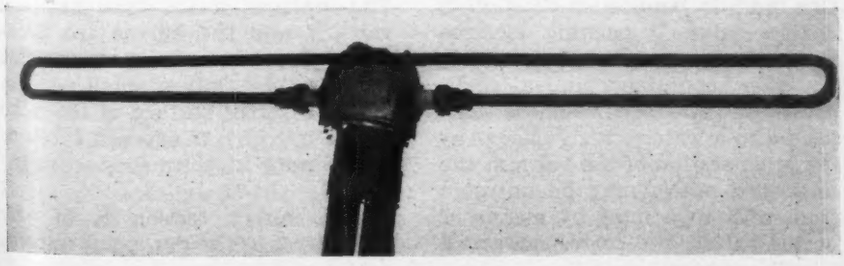


Fig. 4B—Folded dipole antenna impedance as measured at input to transformer sections

Fig. 5—Offset bottom view of antenna in place showing conduit connection for heaters



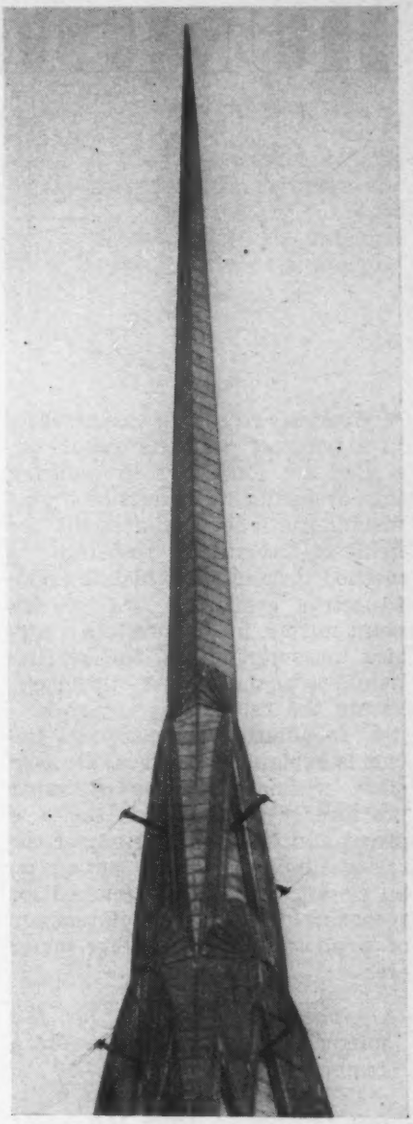


Fig. 6—Chrysler tower showing the original single antennas above the newer folded dipoles

HUMIDITY RECORDING

By PIERRE ERIC MAIER*

Photoelectric evaluation of dew point mirror makes possible precise measurement of relative humidity of air and gases

● Humidity recording has increased in importance with the use of controlled air conditions in industry, improvements in industrial drying machinery, and advances in the field of laboratory research. A method is described which, by photoelectric evaluation[1] of a dew point mirror, makes possible a precise measurement of the relative humidity of the air and other gases within the usual temperature limits. In addition, an electrical circuit is explained which makes possible, without the use of vapor pressure or psychometric tables, a direct and linear indication of the relative humidity in percentage on an electrical pointer instrument or recording device. The requirements of a photoelectric humidity meter are:

(A)—The cooling device for the mirror has to be suitable for a temperature range of —10 to +250°C, and has to operate without supervision from tap water or with a water tank.

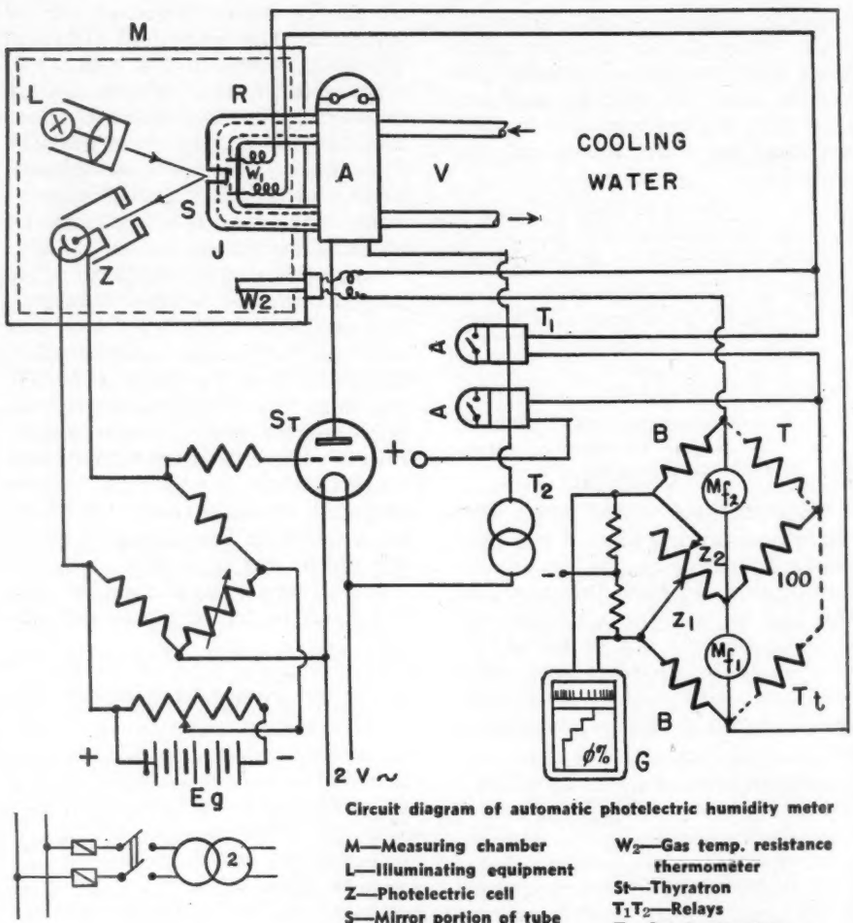
(B)—The indication of the dew point temperature $T°_t$ has to be automatic and continuous.

(C)—Supercooling and overheating of the mirror at the moment of measuring the dew point has to be avoided, or this influence excluded from the dew point measurement.

(D)—The relative humidity ϕ in percentage has to be indicated automatically, from the continuously measured gas temperature $T°$ and the dew point temperature $T°_t$ independently of the total pressure of the gas, so that all recalculations of the measured values on the basis of vapor pressure or psychometric tables would be eliminated.

[1]Reference is made to C. Strobel, Publication: E.T.Z. June, 1940.

*This paper is the result of a private investigation made by the author, now a member of the technical staff, Bell Telephone Laboratories, New York.



Circuit diagram of automatic photoelectric humidity meter

M—Measuring chamber
L—Illuminating equipment
Z—Photoelectric cell
S—Mirror portion of tube
J—Thermal insulation
V—Water valve and relays
W_1—Dew point resistance thermometer
W_2—Gas temp. resistance thermometer
St—Thyratron
T_1T_2—Relays
T—Gas temperature
T_t—Dew point temperature
Z_1Z_2—Bridge circuit values
E_g—Grid bias
G—Recording ohmmeter

In Fig. 1, the U shaped section of hard copper tube R having an external diameter of 8 mm and an internal diameter of 5 mm, projects into the measuring chamber M. One end is connected through a double valve V opening electromagnetically to a water pipe or to a water container under slight pressure. The other end is connected to a water outlet. The opening cross section of the valve at the inlet and outlet may be adjusted from zero to 5 mm² by means of needle valves, and corresponds at a maximum to a fifth of the inside cross section of the tube R.

The tube R at the straight portion of the U is ground, polished, and chromium plated mirror bright. The sections of the tube between valve V and the mirror are thermally insulated by an asbestos wrapping J. Only a small portion of the external surface of the tube at the mirror S is exposed through an opening in the asbestos wrapping.

This mirror section S of the tube serves as the dew point mirror.

The tube with these dimensions will withstand safely an internal pressure of 40 at., which corresponds to a temperature range of the enclosed cooling water of up to 250°C.

At the bright tube surface directly on mirror S, is installed a resistance thermometer W_1 electrically insulated from the tube and under the asbestos stocking, which makes it possible to measure the temperature of the mirror surface. The temperature T° abs. is continuously measured by a resistance thermometer W_2.

The illuminating equipment L with a 2 v lamp in a centralizing holder, a lens and a stop throws a beam of light on the mirror S of tube R. The beam is reflected by the mirror through a stop into a semi-conducting cell Z, having a cell diameter of 12 mm. The cell is connected in a bridge circuit with a voltage supply E_z, potentiometers P_1 and P_2 (for fine and coarse balancing), to the grid of thyratron St. In the plate circuit of the thyratron is the winding of the water valve relay V, the relay T_1 which through its secondary connects the resistance thermometers W_1 and W_2 into the operating current circuit.

Operation procedure

Another relay T_2 in the plate circuit connects through its secondary the outer bridge arms to the operating bridge circuit. When mirror S is clear, cell Z will have light, the thyratron is energized, valve V is open, W_1 and W_2 and the bridge are connected in the circuit, cooling water flows through tube R and cools mirror S until the temperature falls below the dew point.

By suitable adjustment of the opening in valve V, this cooling process may be accelerated or retarded. After the dew point has been reached the mirror will become clouded. The supercooling below the dew point increases as the temperature of the water in the tube falls, i.e., the greater the entrance and exit cross sections of the valve.

As soon as the mirror becomes clouded, the light reflection is interrupted, the cell becomes darkened, the thyratron is extinguished, valve V closes, the flow of cooling water in tube R stops, W_1 and W_2 and the bridge circuit are disconnected. The tube with the enclosed cooling water becomes heated due to the warmer gas of the measuring chamber, the temperature of the surface of the mirror gradually rises until the dew point is reached, and when the latter is attained, the deposit of water on the mirror will slowly vaporize again. When the mirror is again bright, the cell again will be illuminated, the thyratron will be energized, V is opened, W_1, W_2 and the bridge voltage are connected.

As soon as the dew point has been reached on the tube surface, T° and $T°_t$ are supplied to the measuring bridge and at the same moment, the cooling supply is again started and the temperature goes again below the dew point, etc. Marked overheating of the mirror above the dew point cannot occur because:

1—The temperature of the mirror surface, due to the thermal conduction between the fairly small mirror surface to the rest of the thermally insulated tube wall and to the entire water content of the tube, increases very slowly.

2—During the vaporization of the water film from the surface of the mirror, and in view of the slow heating, a temperature arrest point occurs due to the withdrawal of heat of vaporization from the tube wall.

This arrest point is maintained until complete vaporization of the film, i.e., up to response of the thyratron, measurement of $T°_{abs.}$ and $t°_t$ and connection of the bridge, so that the dew point temperature T is still measured with absolute certainty during this arrest point, and without any error due to overheating.

Immediately after energizing the thyratron and opening the valve V, cooling and disconnecting of the thermometer again occur abruptly, so that the temperature maximum of the mirror coincides precisely with the dew point. Hence the dew point is then transposed to a temperature max (a reversal and arrest point). No supercooling can occur during the measuring process since the mirror becomes clouded without delay in the case of this slow alternation at the arrest point. Supercooling occurs only after the thyratron is extinguished, due to the action of the supplied cooling water.

To explain the indication, the following symbols and relationships are given:

ϕ = relative humidity of the gas

pd = partial pressure of the water vapor in the gas at $T°_{abs.}$ and $\phi\%$

ps_1 = saturation pressure of the water vapor at $T°_{abs.}$

$T°_{t\ abs.}$ = dew point of the water vapor contained in the gas at $T°_{abs.}$ and $\phi\%$

ps_2 = saturation pressure of the water vapor at the temperature $T°_{t\ abs.}$

Following are equations for the upper limiting curve of the water vapor:

$$pd = ps_2$$

$$\phi\% = \frac{pd}{ps_1}$$

$$ps_1 = f(T°) \qquad (1)$$

$$ps_2 = f(T°_t) \qquad (2)$$

According to van der Waals, the following equation applies for the upper limiting curve for the computed values of the saturation curve:

$$\text{Log ps} = A - \frac{B}{T_s}$$

where T_s is the absolute saturation temperature of the water vapor at a pressure of ps. A and B are constants.

Range equation

In selecting uniform constants A and B in the range between 20° and 350°, this equation will agree only in certain temperature zones with the actual experimentally determined values of the upper limiting curve of the water vapor.

Therefore, according to the Clapeyron-Clausius equation for the different temperature ranges 20 to 100° C, 100 to 200° C, 200 to 350° C, the most suitable range constants were inserted whereby the following temperature range equations of the limiting curve of the water vapor were obtained:

Remote reading

for 20 to 100° C: $A = 5.9778$, $B = 2224.4$

$$\log ps = 5.9778 - \frac{2224.4}{Ts\ (\text{at abs.})} \qquad (3)$$

for 100 to 200° C: $A = 5.6485$, $B = 2101.1$

$$\log ps = 5.6485 - \frac{2101.1}{Ts\ (\text{abs.})} \qquad (4)$$

for 200 to 250° C: $A = 5.4151$, $B = 2010.8$

$$\log ps = 5.4151 - \frac{2010.8}{Ts\ (\text{at abs.})} \qquad (5)$$

These partial curves check the limiting curve with sufficient precision.

At the dew temperature $T°_{t\ abs.}$ the partial pressure of the water

(*Continued on page* 100)

CANADA'S NEW SHORT

By H. B. SEABROOK and F. R. QUANCE
RCA Victor Co., Ltd., Montreal
Engineering Products Div.

Engineering details of two new 50 kw AM international transmitters operating on 11 frequencies between 6090 and 21710 kc

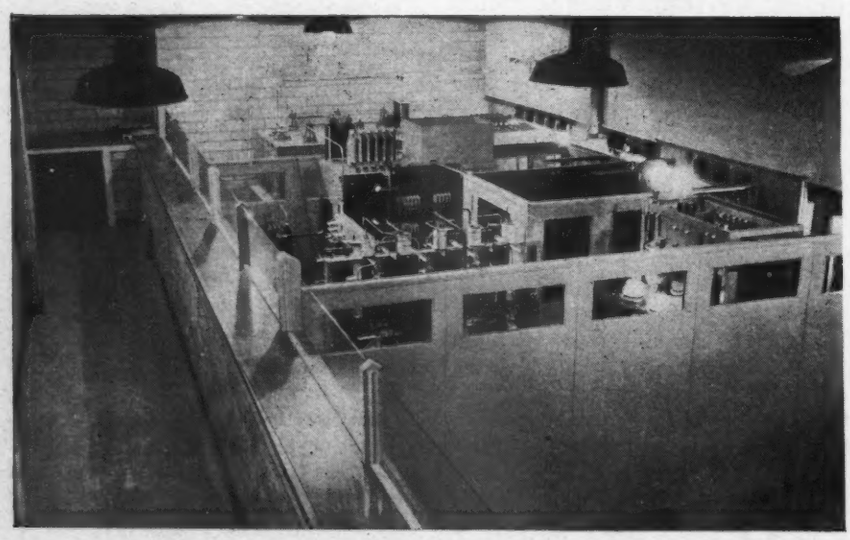
● For twelve hours a day the voice of the Dominion, emanating from the 50 kw transmitter at Sackville, New Brunswick, is heard around the world. Built primarily to give the sons and daughters of the Dominion serving in Europe and the Pacific first-hand news of home, the transmitter has become a powerful factor in Canada's progressive policy of foreign relations —to inform the peoples of the world, via short wave, of her people, products and culture.

After years of careful study, commenced in 1938, the engineering department of the CBC selected Sackville, N. B., as the site for their short wave transmitting facilities. The CBC had, at that time, an RCA type 50-D, 50 kw standard broadcast transmitter, installed at Sackville to serve the Maritimes. It was decided to merge the proposed short wave and existing facilities. In brief, this meant that a new building would have to be erected over the existing structure and equipment without interfering with the scheduled broadcasting service. This feat is a story in itself and is beyond the intent of this article. It is sufficient to say that the job was well done, in spite of wartime restrictions.

Two MI-7330-A 50 kw short wave transmitters face each other across the main control room. Common control room and the 50 kw standard broadcast transmitter occupy the lower floor

A tour of the building would reveal that it is a two and one-half story structure of reinforced concrete. The basic equipment for the two short wave transmitters face across the main control room. The 50 kw standard broadcast transmitter is located a floor lower facing into the common control room, which is approximately 120 ft. long and 40 ft. wide. On the second floor, where the short wave transmitters are located, and at the rear of the building are the antenna switching room, the power control room, and the room for the gasoline-driven standby power supply. In addition there are four control rooms, a master control room, recording room, studio and office space.

Rear view of transmitter showing the rf sections located on each side of the power control room



On the first or ground floor are the transformer vaults, water cooling and ventilation system, workshops, emergency living quarters, test laboratory and staff office space. The fundamental design of the building is such that additional transmitters can be installed by extending the building. In the existing building a room is already

WAVE TRANSMITTERS

reserved for an RCA 7.5 kw short wave transmitter, type ET-4750X.

A very efficient directional antenna system has been erected. Analysis of different antennas revealed the superiority of the resonant multi-element curtain type, and, in view of this, such arrays were erected at Sackville. A gain of approximately 20 db is realized in the high gain arrays and 12 to 15 db in the medium gain arrays. All arrays can be reversed, and slewed to a limited degree on each side of the normal position.

Five high gain arrays are beamed on Europe; when reversed, they serve Mexico, Central America and New Zealand. Three medium gain arrays are beamed on Africa; when reversed they serve Australia and New Zealand. Three additional medium gain arrays are beamed on South America and when these arrays are reversed they serve Asia and parts of Australia. These arrays, because they use resonant radiators, can only be used over a somewhat limited band of frequencies.

Canada has been allocated the following frequencies and call letters:

Call	Kc
C KOB	6090
C HAC	6190
C HLS	9610
C KLO	9630
C HMD	9640
C KXA	11705
C HOL	11720
C KCX	15190
C HTA	15220
C KNC	17820
C HLA	21710

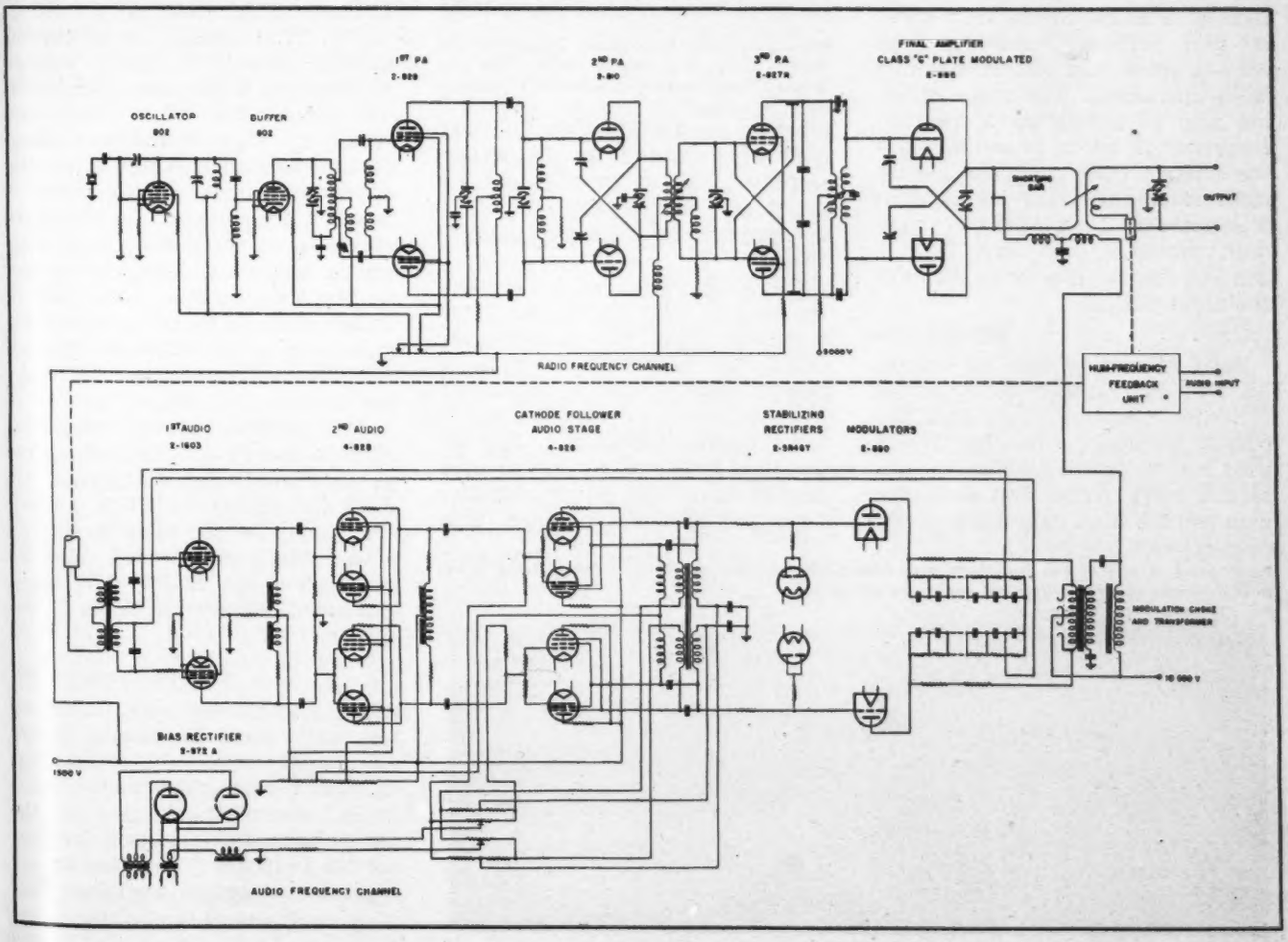
The transmission lines that feed the various antennas are of the two-wire balanced type, designed for a characteristic impedance of 552 ohms. Close to the antenna switch room the lines are tapered to a characteristic impedance of 415 ohms, to facilitate switching and other operations. The lines are connected to the transmitter output terminals through manually operated switchgear. The slewing and reversing which takes place at the antennas is accomplished by remote control selector switches in the antenna switch room.

Transmitter specifications

Two MI-7330-A, 50 kw, short wave transmitters provide the radio frequency power. The transmitters will work into balanced transmission lines of 300 to 600 ohms. Both transmitters may be operated on any frequency from 6 to 22 mc. The frequency stability is 10 parts in a million, which means that the drift is limited to 60 cycles in 6 million cycles.

High level, class B modulation is used. The carrier may be modulated up to 100%. For 100% modulation an audio signal of +8 vu (0 db at 6 milliwatts) is required. The specified overall audio frequency response is ±1.5 db from

Schematic circuit diagram showing the 6 stage radio frequency channel with its class C final amplifier, and below it the associated audio equipment which provides sufficient high level class B power to modulate the carrier fully



30 to 10,000 cycles. The envelope distortion is less than 4% rms at 90% modulation at 1,000 cycles. Average program output requires 135 kw from a 2,300-volt 3-phase 60-cycle source. For full modulation 170 kw of power is required.

A view is shown of the front panel of one of the two transmitters. The two interlocked doors at each end give access to two rf channels. The center door opens on the power control equipment. The extreme doors at each side give access to all rf exciter and power amplifier controls. The five meters at each end indicate filament voltages, grid and plate current for the two power amplifier stages. The center door opens to a small enclosed control room where the main circuit switches, breakers and control relays are located. At the rear of this control room an electrically interlocked door allows access to the modulator, low voltage and high voltage rectifiers and control contactors.

The meters over the central section, left to right, indicate modulator filament voltage, modulator plate current, low, intermediate and high plate voltage, main supply voltage, power input and control voltage. The two doors at the right give access to the right hand rf unit. These doors may be opened when the left rf channel is in operation. The right channel may be set up on a specified frequency in about 15 minutes but the change over from the left to right rf channel may be made in 5 seconds if both channels have been previously set up. This is done by operation of one switch on the front panel.

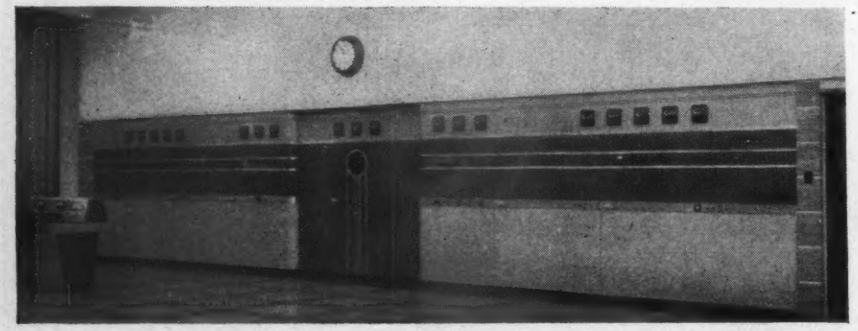
Rf circuits

Each rf section has six stages. An RCA-802 is used as a crystal oscillator operating at one-half the output frequency. Another 802 is used as a buffer-doubler in the second stage. The first amplifier uses two 828 high gain beam power tubes in push-pull. Two 810's are used in push-pull in the second amplifier. All of these stages are tuned by varying capacities and selecting taps on the tank inductances.

High gain array beamed on Europe and reversible for Mexico, Central America and New Zealand. Additional arrays serve South America

Two 827R, air cooled, power tubes are used in push-pull in the third amplifier stage. These tubes are capable of delivering about 2 kw output. The tuning in this stage is made through fixed capacities and a variable inductance. The inductance is varied by means of a shorted turn. The power amplifier stage uses two water-cooled, type 880 triodes in push-pull. The tank inductance consists of a one-turn coil or loop constructed of copper pipe. The inductance is varied by using a shorting bar.

Front panel of one of the two short wave transmitters showing interlocking doors giving access to rf channels, power amplifier and power control equipment



Audio circuits

A single-channel, push-pull, four-stage modulator is used to develop the modulating power. Two 1603's in push-pull are followed by four 828's in push-pull parallel for the first two stages. These drive the two 880's modulators through four 828's operating in push-pull-parallel as a cathode follower. Two 5R4GY's are used across the grids of the 880's to insure audio stability on peak modulation. Feedback from the plate of each modulator to the input of the 1603's is used to obtain low distortion and a flat frequency response. The 880 tubes are connected push-pull into a modulation transformer and modulation reactor where the modulation voltage is effectively placed in series with the plate supply to the power amplifier. The overall gain from input to output of the modulator is 66 db which represents a power gain of over 4 million to 1.

Power equipment

Two voltage regulators are used to regulate the main supply within ±10%. These regulators do not act quickly enough to follow voltage changes due to program modulation but correct for "slow time" line variations. Three distribution transformers are used to step down the 2,300-volt 3-phase to 230 volts, 3-phase. The primaries of the three single-phase transformers are connected either delta or wye to step up the 2,300 volts to 6,600 volts or 11,000 volts to feed the main rectifier. A small 5,000-volt step-up transformer is used to supply the low voltage rectifier.

Four rectifiers provide the direct current supply for the tubes, one at 10,000 volts for 880 plates, one 5,000-volt supply for 827R's, a 1,500-volt supply for the early stages and a bias supply at 600 volts. With no modulation but 50 kw of rf being generated, 120 kw of power is required.

Control equipment

The cooling air and water for the tubes must be flowing before any power, either to the filaments or plates, is applied to the large tubes. Switches operated by the air or waterflow are used for protective purposes. The bias supply must be on before applying plate

(*Continued on page* 102)

IRE-URSI CONVENE

Scientists review progress in the measurement and utilization of UHF signals and propagation characteristics

• The joint meeting of the International Scientific Radio Union, (U.R.S.I.) with the I.R.E. (Washington, D. C. Section), drew about 400 physicists and radio engineers to Washington May 2-4. A total of 49 papers during the six sessions were devoted to radar; tropospheric propagation; ionospheric propagation; theory; instruments and measurements; circuit elements; and antennas.

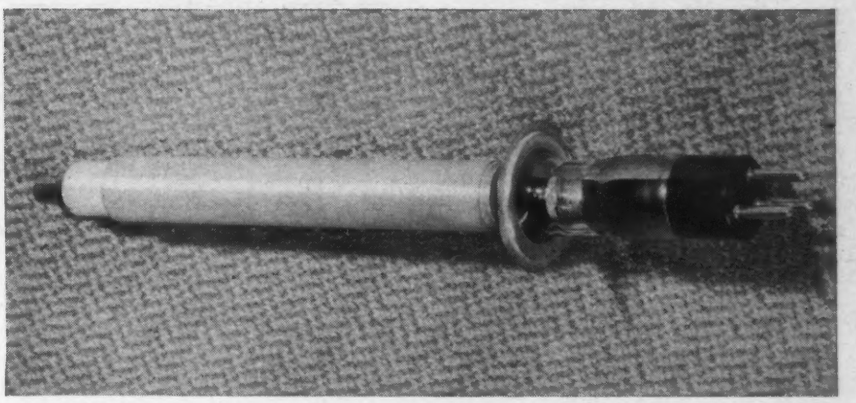
The program was started with an analysis by P. R. Adams and J. Allison (F. T. L. Inc.) of the frequency and power characteristics of a ranging system (Loran) using frequencies of the order of 70 kc per second. It was disclosed that power requirements of the order of 100 kw near the equator and from 7 to 10 kw in northern latitudes would be necessary to make such systems practical.

F. P. Isely (N.R.L.) described methods for adjusting radar equipment in the field, using artificial targets which apply reflected energy signals to the receiver after known intervals, after the passage of the transmitter pulses. These "targets," usually in the form of a high Q cavity known as an echo box, absorb energy from the transmitter and re-radiate it during definite intervals. The calculations of the necessary Q for such a cavity were given, with descriptions of some of the units used for this purpose.

Centimeter wave lengths

A. L. Samuel and J. W. Clark (B.T.L.) described a wide tuning range microwave oscillator tube (2K48 or 2K49) of the reflex klystron type with facilities for coupling to an externally-adjustable output line wherein tuning was accomplished by a moving piston. The tuning should be varied over the four to ten centimeter range using the $\lambda/4$ mode, two to six centimeters using the 3 $\lambda/4$ mode and one and a half to five centimeters using the 5 $\lambda/4$ mode.

D. F. Winter (Radiation Laboratories, MIT) described oscillographic measurements having a time resolution capability of the order of one millimicrosecond. The oscillograph used a DuMont K1017 tube operating at the potential difference of 25KV. This instrument was capable of showing transients having a writing speed of 300 in. per microsecond at a deflection sensitivity of 180 volts per in.



Wide range microwave oscillator tube (right) and adjustable cavity (left). Samuel and Clark (BTL)

A method of calibrating wavemeters and oscillators in the microwave region (of the order of 7 cm) was described by L. E. Hunt (B.T.L.). As shown, the unknown frequency is compared with certain high harmonics from a crystal oscillator, both being separately heterodyned with the output from a frequency modulated oscillator, modulated by a saw-tooth waveform. The modulation products are mixed and passed into a communications receiver, amplified and applied to the cathode-ray oscillograph vertical deflection system. The horizontal sweep of this tube is synchronized with the saw-tooth modulating voltage of the FM oscillator. Two vertical pips (as shown at A-A') appear on the oscillograph pattern separated along the time scale by a distance (t) which represents twice the frequency of the communications receiver setting. Since the horizontal sweep is linear, this separation represents a known frequency difference.

The unknown frequency applied through a similar circuit superimposes the other vertical pips (B and B') along the horizontal scale. The unknown oscillator is shifted, and when these two sets of deflections coincide, the frequency of the power oscillator matches the crystal harmonic.

S. Kass, L. A. Pick and A. C. Trakowski, discussed the form of radio signals produced by lightning. A storm warning communication circuit consisting of special radio networks containing widely separated stations, was used to study atmospheric static disturbances (sferics). Since about one-sixth of the air crashes occurring during the war were caused by weather hazards, a knowledge of thunderstorms is an important factor in the reduction of this serious hazard of flying.

Tropospheric studies

The session on tropospheric propagation involved a description of long-time records of reception intensities of a 44 mc signal obtained at the Cosmic Terrestrial Research Laboratory, by Drs. Harlan T. Stetson and G. W. Pickard. This data indicated the importance of the moisture content of the air in its effect on the transmission path of signals by changing the refractive index of the atmosphere.

The reflecting properties of icebergs on radar waves of the 3 and

10 cm lengths was reported by L. E. Brunner (Coast Guard). Experiments during the last ice patrol seem to favor the 10 cm wavelength. It was pointed out that the time has not yet arrived when a vessel can steam through an ice barrier with full assurance of safety, based only on radar disclosures of the location of bergs, although this will become a reality after more experience and experimentation.

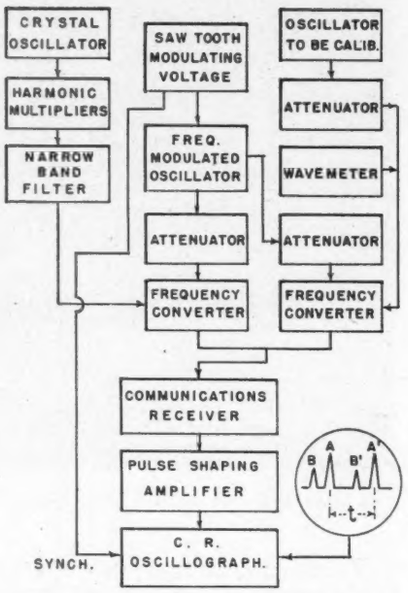
A paper by E. Dillon Smith and R. D. Fletcher (U. S. Weather Bureau), was devoted to the study of the obstruction and attenuation of radio and radar signals by scattering and absorption by particles of moisture in the air. Theoretical curves of the absorption coefficient and refractive index make it possible to compute the attenuation due to raindrops, clouds and fog.

Earth reflections

A two-part paper by D. E. Kerr (Radiation Labs. MIT) covered the method of analyzing interference between direct waves and earth reflected waves at microwave frequencies. The commonly utilized lobe pattern method for the study of microwave propagation characteristics was analyzed. The effect of the atmosphere on the propagation of centimeter wavelengths was shown to take place in three different ways: Oxygen and water vapor absorb energy at particular wavelengths, and water in liquid and solid forms in the atmosphere both absorb and scatter energy, producing a combined effect that may be rather large in the vicinity of 2 cm wavelengths. Refraction also causes very large fluctuations in signal strength. The familiar concept of an equivalent earth's radius to account for the effect of refraction as it has been used in preliminary studies for several years, has proved inadequate to explain most refraction effects and new experimental and theoretical methods have been developed to explore the mechanism of radio wave refraction.

A study of radio interference on aircraft when flying through precipitation was reported by Ross Gunn (NRL). A plane flying through moist air or snow accumulates a large charge with respect to the surrounding atmosphere which may become as high as 450,000 volts. Radio interference results from corona currents produced by the dissipation of these voltages.

At the Ionospheric Propagation session a report by H. W. Wells, J. M. Watts, and D. E. George, (Carnegie Institution of Washington) disclosed a new method of analyzing rapidly moving ionospheric clouds. The method consists of a continuous series of "panoramic" pictures recorded on motion picture film at short intervals showing the reflec-



Visual match against crystal harmonics used in microwave calibration system, Hunt (BTL).

tion at a number of frequencies from these clouds. Pictures taken during magnetic disturbances, such as those which occurred March 25 and 26 this year, were shown. These clouds coincided with the F-layer and caused rapid fluctuation in the ionization effect. By viewing such records in rapid sequence a much clearer insight can be gained as to the mechanism of ionization.

A method of preparing nomographic charts relating to the critical and maximum usable frequencies with respect to solar and magnetic effects on the ionosphere was described by M. L. Phillips (Bu. Stan.). On these charts the third variable takes care of the reception characteristics over the great circle path on the earth's surface to where the data was recorded, and the time of year. The characteristic shape of the scale which takes into account these latter data discloses certain characteristic information in itself.

A paper presented by M. B. Harrington (Bu. Stan.) reports the study of the variability of field intensities at frequencies ranging from 770 kc to 15 mc with a view to obtaining a utilization factor that could be applied to field intensity data and that would assure a usable transmission band over a particular percentage of the time. In general it was found that multiplying the required field intensity by a factor of two would assure adequate signal intensity on 90% of the days.

J. V. Lincoln (Bu. Stan.) described the method used in correlating information reports from various operators in the field and establishing a common denominator whereby these reports could be handled on an equal basis.

It has been generally assumed that ionospheric observations should be made on a "time of day" comparison basis, that is stations having the same longitude would have similar characteristics. This assumption has been shown by Newbern Smith (Bu. Stan.) to be questionable because of differences in the field the magnetic latitudes introduce. These effects can be handled by the use of a zoning factor depending on the magnetic latitude, the latter being somewhat different from the geographical latitude.

Phasemeter

A description of a direct reading phasemeter covering the audio frequency range was given by E. R. Haberland (Naval Ordnance Lab.) Here two frequencies, the phase difference between which is to be determined, are amplified, passed through two stages of limiting, differentiated and then passed into a polarity discriminator circuit. The latter is similar to a form of flip-flop circuit. The transfer intervals when this circuit is reversing depend upon the arrival time of the pulses which result from the differentiated square wave version of the input signals. The integrated flow of current in the anode circuit of the polarity discriminator is therefore a measure of the phase displacement between the two frequencies. The instrument can be arranged to read zero phase angle at the center of the indicator scale which is calibrated ± 180 deg. at one extreme of the scale, with a full scale equal to a 360 deg. displacement.

Methods for stabilizing the frequency of an audio oscillator of the Wien bridge type were reported on by C. B. Leslie (Naval Ordnance Lab.) A typical interpolation oscillator can be frequency stabilized to within $\pm 0.02\%$ over the operating range.

F. V. Higgins (FCC) compared the time required for solving and

the operational difficulties attending several common methods of harmonic analysis based on interpreting the contours of curves using the four methods of analysis: analytical, graphical, Fisher-Hinnen, and Brown.

A low-frequency transient voltmeter was described by C. N. Mooers (Naval Ordnance Lab.). By the use of inverse feedback with a peak indicating diode circuit, a voltmeter was produced that is capable of measuring the negative potential of a transient pulse of 5 volts or less which builds up during intervals of a few milliseconds to several seconds, with an accuracy of ½%.

A paper by J. J. Freeman (Bu. Stan.) analyzed the field generated in a piston-type attenuator operating on the TE_{01} mode. The relative merits of circular and rectangular attenuator cross-sections were discussed.

K. Lark-Horovitz, (Purdue) gave a brief summary relating to the latest concepts of electrical conduction through semi-conductors with particular reference to crystal rectifiers. He followed this with a review of Germanium high voltage rectifiers and photocells, taking up the characteristics which make them useful not only for rectifiers, but also in the field of non-linear and negative resistance elements, photosensitive cells and temperature sensitive devices. As a photocell, a sensitivity exceeding that of regular phototubes has been attained

Klystron noise

A paper was presented by J. B. H. Kuper and M. C. Waltz (MIT) on the noise from reflex Klystrons. When these tubes are used as local oscillators in microwave superheterodyne receivers a considerable amount of noise is experienced.

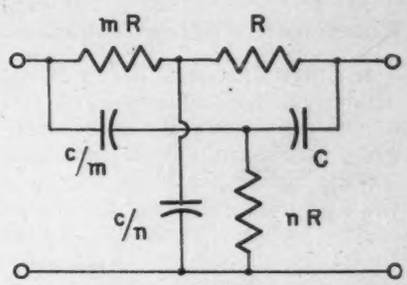
A method of designing band pass and band rejection microwave filters using quarter-wave couplings was discussed by R. M. Fano and A. W. Lawson (MIT). This paper described methods of transforming lumped-element filter circuits into microwave structures and discussed the advantages of using quarter-wave coupled filters over other types of microwave filters. The determination of the resulting characteristics was discussed.

A survey of the high frequency characteristics of commonly-used types of resistors was made by R. F. Field (General Radio Co.) The reduction in resistance values at high frequencies, known as the Boella effect, has been attributed to the capacitance effects between conductive elements in such resistances. It was shown that the dielectric losses taking place in these capacitance elements accounts for the shape of the high frequency characteristic curves of resistors.

Two papers were presented on the parallel-T form of RC networks. The first paper by L. Stanton (Brown Instrument) developed the general theory and application of parallel networks and gave a survey of the most usual applications. The method of using such a network as a negative feedback circuit was described.

The second paper by H. S. McGaughan (Naval Ordnance Lab.) discussed a method of unbalancing parallel-T networks which have the characteristics of producing a minimum in transmission at one frequency and shifting the phase by 180 deg. at that point. This feature is of particular interest in the design of RC-tuned oscillators. Another effect of unsymmetrical networks is that the characteristic input and output impedances may be different at each end of the network. Several examples of this non-symmetric connection were given. The basic circuit is shown in the sketch.

An automatic level control for audio frequencies was described by W.

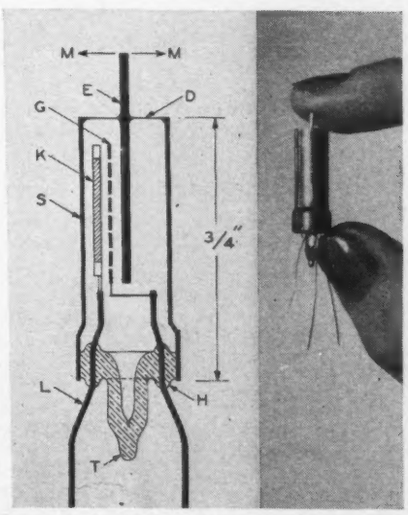


Unbalanced parallel-T net-work (McGaughan)

R. Turner (Naval Ordnance Lab.). A variable-gain amplifier using a 6SA7 tube was regulated by a potential derived from the voltage appearing at a control point later in the system. The potential at this control point was amplified and rectified in a full-wave bridge rectifier circuit and the resulting dc was amplified in a direct coupled amplifier stage. The output of the latter was passed through voltage limiter circuits and a low-pass filter and furnished the control bias of the variable gain stage of the main amplifier. A level of signal was maintained within 4% for a 60

(*Continued on page* 96)

RCA's "Vibrotron" Tube Has Wide Application



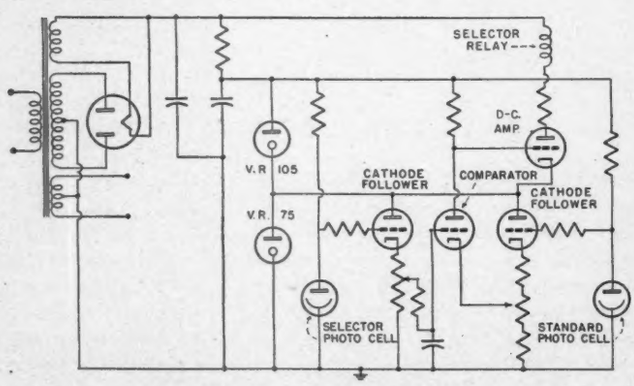
In RCA's "Vibrotron" tube, motion of the movable electrode E in directions MM is transferred through a thin metal diaphragm to affect the electron flow of the triode consisting of electrodes K (cathode), G (grid) and E (movable anode). Leads L are brought out through a glass seal (H) in the metal envelope (S) with exhaust tip at T

A new type of vacuum tube, primarily developed for use as a phonograph pick-up but useful also for many industrial control and measurement applications, is being put in production by RCA Victor Division of RCA, Harrison, N. J. It is styled "Vibrotron," is about an inch long, one-quarter inch in diameter and weighs one-fifteenth ounce. The tube is a metal triode with leads brought out through a glass seal at one end and at the other an extremely thin metal diaphragm to which there is connected a projecting arm, movement of which converts mechanical variations directly into variable electron flow. For record reproduction it is claimed that the tube makes possible a system having low acoustic noise and needle chatter, that it will withstand severe treatment and is stable under wide temperature and humidity changes. It operates as an integral part of the pick-up head without pre-amplifier or coupling transformer.

TUBES ON THE JOB

Electronic Coffee Roaster

An ingenious use of infra-red light coupled with photocell control has been worked out for the automatic roasting of coffee. Machines shortly will be placed on the market. The basic principle, discovered by the inventor, August A. Torres (Hotel Biltmore, New York) involves the difference in the reflective property of coffee beans as they change from the raw to the roasted state. Heat is generated electrically, the whole automatic roasting process requiring about two minutes. With the raw coffee in a rotating drum, a photocell scans the reflected infra-red light. A second (comparator) photocell looks at the light source. The plate voltage of the first photocell is applied to the grid of a cathode follower stage and a portion of the output of this stage is applied to the grid of the comparator stage. The output voltage of the comparator stage is proportional to the difference in plate voltage of the plate voltage of the two photocells and is a measure of the difference intensity of the light from the source and the light reflected from the roasting coffee beans. Output of the comparator stage is used to operate relays which cut off the heaters, release the roasted coffee into a second rotating drum under air blast to cool it, whence it is automatically weighed and delivered for packaging.



The electronic coffee roaster resembles a cash register and is automatic. Heat is generated electrically, roasting operation being controlled by reflective property of beans under infra-red light. Schematic at right indicates method of operation

Miniature Welder

High speed precision welding is brought right into the production line for such jobs as instrument making, electro-chemical apparatus and radio part assembly with the new miniature welding unit developed by the Industrial Electronics Division, Raytheon Mfg. Co., Waltham 54, Mass.

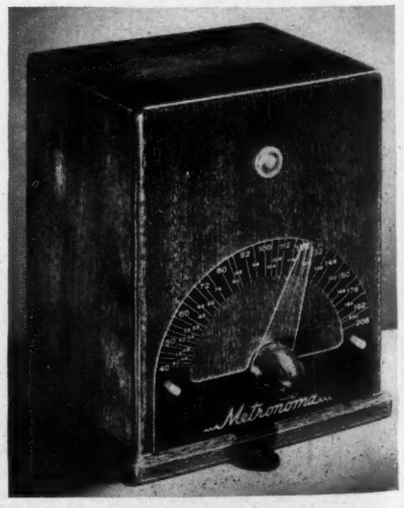
The power supply and control box is 10 in. high and requires a bench top area about 13 in. square. With a current drain of 3 amp. for the maximum setting this equipment will work off any 115 v 60 cycle light line. When the stored energy principle of an electrostatic charge in a capacitor building up and then discharging through gas filled rectifier tubes the power consumption from the 115 v line is relatively stable. The output can be controlled with a single adjustment. The only other control on the box panel is a three position capacitor switch allowing the proper selection of capacitor values to be inserted in the timing circuit. After these two settings are made for any particular material and thickness of joint, the unit produces constant uniform welds.

The foot operated welding head allows a pre-set pressure to be applied to the welding spot and also automatically triggers the power. Sixty to 120 welds per minute are possible, depending on the setting of the voltage and capacity controls. Practically all high thermal conductivity metals and their alloys can be welded; these include iron, aluminum, copper and copper alloys, nickel and nickel alloys, tantalum, platinum, tungsten, gold, constaten and stainless steel.

Capacitor discharge permits 60-120 welds per minute with this miniature bench type welder

Electronic Metronome

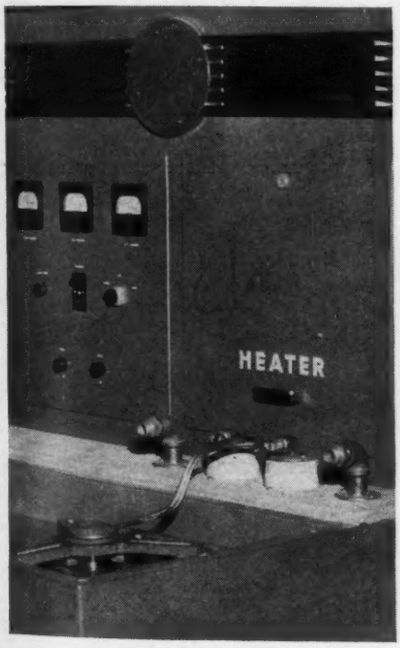
This all-electronic metronome uses a thyratron tube to replace pendulums. A simultaneous audible time-beat and flashing light may be selected in any tempo in the range between 40 and 208 beats per minute, directly from a calibrated dial. The volume and tone of the audible beat may be varied over wide limits. For 110-v a-c only. Distributed by G. Schirmer, Inc., 3 E. 43rd St., N. Y. 17, N. Y.



Automatic Surface Hardening

Heart of a versatile new custom heat treating plant, the Dexter Metal Treating Co., Oakland, Calif., is a 15 kw, GE induction heater—one of the first of its type to be installed on the Pacific Coast. The equipment is used either for surface hardening or for joining metals by silver soldering or brazing. An accessory soon to be installed is a machine to do scanning for surface hardness, which will control the passage of a shaft through the coil and spray quencher. In operation, a surface hardness to a depth averaging 1/16 in. will be produced on a continuous, full-automatic basis. The depth may be varied through control of speed and power plant. The unit is operated in the neighborhood of 500 kc.

Typical is a current order for surface hardening certain portions



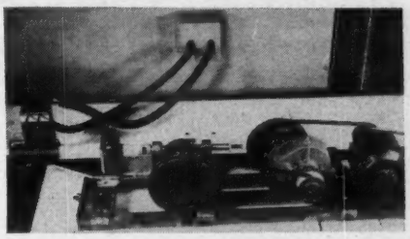
Surface hardening of small parts is automatic and provides for continuous operation

of a steel shaft. The customer had been paying 82 cents each, for a method whereby each shaft was first carburized all over, then scraped with final reheating of the portions requiring hardness. Dexter does the work for 17 cents per unit —and total cost to the customer is well below the other, even though a superior grade of steel must be used.

Automatic Bearing Hardening

Using induction heating and a simple feed mechanism based on the principle of the breech loading rifle, Sprague-Sells Division, Food Machinery Corp., Hoopeston, Ill., is surface hardening 3-in. bearing sleeves at the rate of 1200 an hour.

The feeding unit consists of an eccentric cam driving a piston. A



Applying breech loading principles, 3-inch bearing sleeves are hardened 1200 an hour

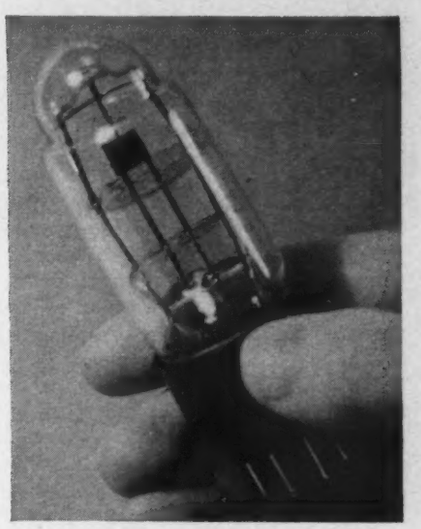
magazine feed built in the worktable raises the sleeves from a storage bin under the table to the proper feeding position. The piston then pushes the bearings through the hf heating coil at a pre-determined uniform rate of speed. A quartz tube fitted inside the heat coil acts as a positioning guide to maintain concentricity between the bearing sleeve and the coil and is also used as an insulator to prevent shorting of the coil turns. The travel of the piston stroke is adjustable to compensate for the various lengths of sleeves handled.

The induction heating equipment is a 30 kw unit developed and built by Lepel High Frequency Laboratories, Inc., 39 W. 60th St., New York City 23. The operating frequency on this particular operation is 380 kc. The heater, however, has a frequency range from 125 to 450 kc which is wide enough to match practically any load or load coil conditions that may arise with any special heating jobs in the plant. Frequency selection can be made in less than 2 minutes with a single hand-wheel control; a meter being used as a resonance indicator.

Concentrated Arc Lamp

As a light source for narrow-beam and high-intensity projection applications, a new glass-enclosed arc lamp developed by the Water Mill Laboratories, Western Union Telegraph, Water Mill, Long Island, N. Y., has many advantages over presently existing types. For use in optical microscopes, and for projection and photographic enlargement it produces exceptionally sharp images with extreme depth of focus.

The light spot in the smaller lamp sizes is a sharply defined circular area approximately 0.003 in. in diameter. This is formed on a specially prepared zirconium oxide cathode. Ionic bombardment brings the oxide surface to its melting point and a brilliant white light, covering the spectrum from 2500 Angstroms on up through part of the infra-red, is emitted by the molten surface and the excited zirconium vapor. Maximum response is in the neighborhood of 10,000



Concentrated arc lamp, 10-watt size, which has zirconium coated cathode, produces great light

Angstroms. The brightness of this arc is about ten times that of an ordinary tungsten filament. This concentrated arc lamp is made in four different sizes at the present time—2, 10, 25 and 100 watts. Experimental models up to 1500 watts have been built for possible use in theatre and home motion picture projectors. All lamps operate on direct current and need special power supply units and circuits designed to meet their peculiar requirements.

ROTARY HEATING JIG

By adapting a manually operated rotary holding chuck to their 15-kw induction heater, Willey's Carbide Tool Co., Detroit, Mich., has stepped up output of small ¼-in. cutting tool tip brazing to 400 units per hour per operator; ¾-in. square tool bits are handled at the rate of about four a minute

SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

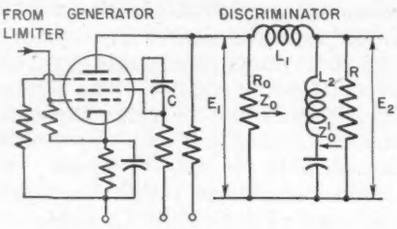
Pulse-Time Modulation

J. Zwislocki-Moscicki (Bulletin des schweizer elektrotechnischen Vereins, July 25, 1945, and August 22, 1945, Nos. 15 and 17)

In this pulse-time modulation scheme, basically different from the American systems,* the recurrence frequency of short, low-frequency pulses is frequency modulated in accordance with the signal to be transmitted, and the low-frequency, frequency-modulated pulses are used to key a high-frequency transmitter on and off. In the receiver the low-frequency pulses are derived from an intermittent carrier and the original signal obtained by a discriminator. Steepness of the pulse edges, average recurrence frequency of the pulses and deviation of the recurrence frequency due to the modulating signal are three characteristics of the system which should be suitably chosen.

In a particular apparatus for experimental purposes the high-frequency section of the transmitter contained a 30 mc generator, a keying stage and an output stage. In the low-frequency section impulses of an average recurrence frequency of 50,000 cycles per second were generated by heterodyning two approximately one-megacycle waves and passing the 50,000 cycle difference frequency through an overloaded amplifier tube to obtain pulses from the 50,000 cycle sine wave. One of the megacycle waves had been previously frequency modulated by the signal so that the recurrence frequency of the 50,000 cycle pulses was also frequency modulated. In other words, the pulses were more densely spaced for high amplitudes of the modulating signal than for lower amplitudes. The pulse shape was equivalent to the superposition of the first harmonic and the fundamental, if the amplitude of the first harmonic is half that of the fundamental; they were closely enough to a rectangle for the requirements. With this arrangement, a tone frequency of 10,000 cycles could be transmitted satisfactorily.

The high-frequency section of the receiver is similar to that of a conventional receiver for amplitude modulation; an intermediate frequency of 5 mc was used. The first rectifier is followed by a limiter; care should be taken that the tops of the impulses are applied with a positive sign to the limiter. The



Demodulator for carrier pulses where the pulse-recurrence frequency is frequency modulated

amplitude limiter consists of a grid-leak detector with a high grid resistor preventing the flow of grid current. Consequently the positively applied pulses are clipped at the bases only but the tops are passed freely; this results in a reduction of disturbances and in a narrowing of the impulse width.

At the plate side of the amplitude limiter the pulses are negative. They determine the recurrence frequency of square waves generated by a pentode connected as a dynatron oscillator. The square wave output is secured by suitable distribution of the cathode current between plate and screen grid. The frequency-modulated square waves are applied to a discriminator which is required to pass essentially only the first harmonic of the square wave and which presents a pure resistance to the square wave generator. The discriminator shown operates as a low-pass filter where R_o is much smaller than Z_o and R, the equivalent resistance of a rectifier, is much larger than Z_o'. Computations show that for the assumptions made, the ratio E_2/E_1 or output voltage to input voltage (the input voltage is maintained constant) is given by the expression:

$$\left|\frac{E_2}{E_1}\right| = \frac{R}{\sqrt{R^2\left(\frac{\omega^2 C L - 1}{\omega^2 C L_2 - 1}\right)^2 + \omega^2 L_1^2}}$$

where $L = L_1 + L_2$. Suitable choice of the circuit constants permits the ratio E_2/E_1 to be proportional to the angular frequency ω within wide limits.

Calculations regarding the effect of a disturbing signal are presented. The system may be advantageous for distance communication because short impulses are less subject to fading and effective amplitude limitation may considerably reduce interference.

See patent No. 2,392,546 summarized on page 82 of this issue.

Electrolytic Selenium Photo-Cell

A. von Hippel, J. H. Schulman and E. S. Rittner (Journal of Applied Physics, April 1946)

The electrolytic photocell consists of a metal electrode, completely coated with metallic selenium, immersed in an aqueous solution of an electrolyte, preferably selenium dioxide, together with an auxiliary electrode of a noble metal, like platinum, or a second selenium-coated electrode. On the application of an external voltage of the order of 2 volts making the auxiliary electrode the anode, the cell becomes immediately sensitive to light incident upon the selenium cathode. The photocell possesses a short circuit sensitivity of the order of 1000μ amp./lumen and a dark current of 0.2 to 2.0μ amp. for a total cathode area of 2 cm^2.

A report is presented on the characteristics of these photocells as a function of operating voltage, temperature, external resistance, and time. The characteristics of the electrolytic selenium photocell rival most closely those of present commercial selenium "barrier layer" type cells. Its main advantages over the latter type are higher sensitivity, the possibility of making the active surface in practically any shape, and perhaps ease of manufacture. The need for an external voltage supply, the resulting dark current and higher noise level, and the temperature limit imposed by freezing of the electrolyte are its main disadvantages. An electronic feedback circuit is described which maintains the voltage across the

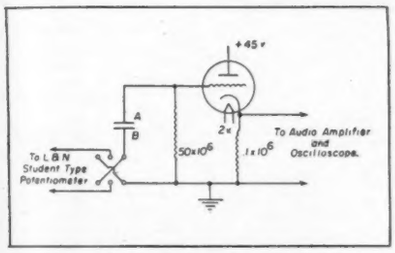
*Electronic Industries, Nov. 1945, p. 90, and Dec. 1945, p. 83.

cell constant improving its operation. It is generally applicable to photo-conductive and photo-voltaic cells.

Measuring Contact Potential Differences

W. E. Meyerhof and P. H. Miller, Jr. (Review of Scientific Instruments, January, 1946)

The apparatus is intended for the study of metal surfaces in gases or in vacuum. It permits the determination of contact potential differences to 1/100 volt between any two flat metal samples having areas larger than two square millimeters. Time effects on surfaces in intervals varying from minutes to days and effects of various treatments of the surfaces may be investigated with the device.



Contact potential difference indicator

In operation the standard metal surface A and the surface of the metal sample B are approached rapidly to within a small distance, say 0.01 cm, causing an audio frequency pulse across the grid resistor of the electrometer tube, which is connected as a cathode follower. The pulse is amplified by a factor of 10^3 and applied to the vertical plates of an oscilloscope. The contact potential difference between the surfaces A and B is determined by adjusting the potentiometer until the pulse can no longer be seen on the oscillograph. With this null method evidently slow changes in the amplifier characteristics are of no consequence. For more accurate measurements the oscillograph deflections are plotted against the potentiometer readings and the null point determined as the intersection of this plot—which is a straight line—and the x-axis.

Non-Linear Mixers

H. Stockman (Journal of Applied Physics, February, 1946)

Several methods are described for the computation of the output of non-linear mixers. All methods are tried out for a particular example and their advantages and disadvantages explained in connection with this example. It is found that no "best" method exists.

UHF Impedance Measurements

J. M. van Hofweegen (Philips Technical Review, Eindhoven, Netherlands, Vol. 8, No. 1, January, 1946)

The method of determining resistive and reactive component of an impedance by establishing the damping and detuning introduced if the impedance is connected in parallel with a resonant circuit is extended to decimeter waves. A Lecher wire system is substituted for the resonant circuit and a diode voltmeter requiring only relative calibration is used as indicating instrument. An additional Lecher wire system is provided for compensating purposes and to assure accuracy of measurement. Details of a particular circuit for 50 cm waves are given and appropriate formulas are included.

Radio Lens

W. E. Kock (Bell Laboratories Record, May, 1946)

The radio lens was developed to shape into a narrow beam the ultra-high frequency wave energy which carries the intelligence in microwave communication systems.

To construct the radio lens, a medium was required that changes the phase velocity of the waves, as glass does for light, and which is not too massive for practical handling as solid lenses made of plastics or other dielectrics would be. It appeared that wave guides may prove a solution because the phase velocity of radio waves is increased as they pass along a metal tube or between metal plates; the amount of velocity increase depends on the wavelength, the length and contour of the plates and the distance between them.

As illustrated in the left-hand drawing of Fig. 1, the radio waves

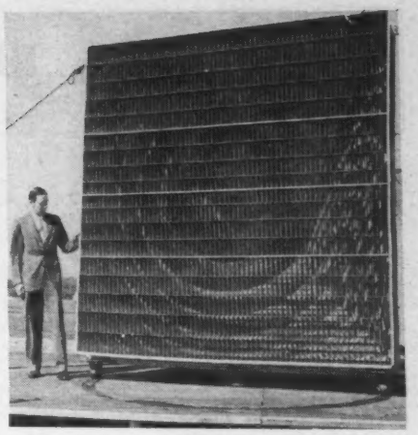


Fig. 2—Photograph of wave-guide lens

emitted from the source spread out and approach the lens in a curved wave front. To convert this diverging beam into a parallel beam, the metallic lens speeds up the edge rays relative to the center rays so that the wave front is flattened. In practice it is advantageous to build a metallic lens in steps, see right-hand drawing of Fig. 1, rather than in a continuous profile.

The antenna shown in Fig. 2 is built along these lines, fed through a wave guide in the rear, the waves spread out along a horn-like shield to the lens which focuses them into a pencil-beam. A similar combination of shield and lens at the receiving end takes in the waves and performs the reverse operation of focusing the energy into a wave guide. A radio wave beam only six minutes wide was produced with an experimental 20-ft. metallic lens.

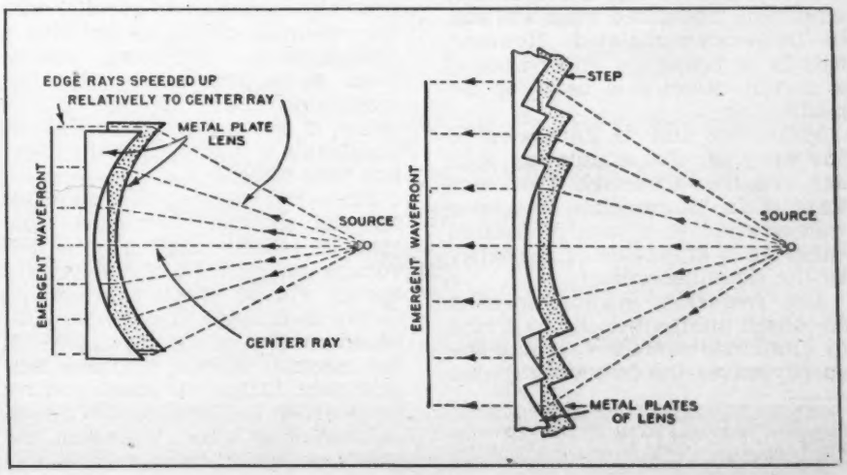
Radar Indicates Meteors

O. P. Ferrell (Physical Review, January, 1946)

Scattering of radio signals about 40 Meg. has been observed and it is attributed to reflection from high

(*Continued on page 96*)

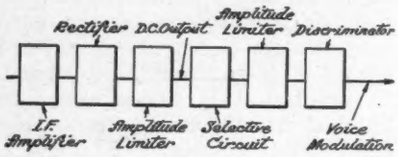
Fig. 1—Two metal-plate lenses for concentrating uhf waves by speeding up edge rays



NEW PATENTS ISSUED

FM Pulse Receiver

In this receiver for pulse modulated carriers, the output of the intermediate amplifier is rectified and limited to yield constant amplitude direct current pulses. These direct current pulses, the phase or frequency of which is varied according to the signal they are carrying, are passed through a selective circuit or band pass filter that transmits the average pulse frequency plus and minus such frequencies as are necessary for the transmission of the modulation.



This circuit is so designed that its output consists of a sinusoidal wave which is frequency modulated with the signal. A limiter and a discriminator follow the filter stage.*

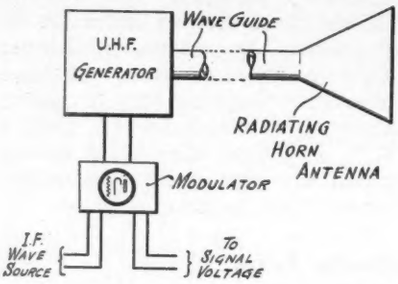
H. O. Peterson, RCA, (F) February 20, 1942, (I) January 8, 1946, No. 2,392,546.

FM-AM Conversion at UHF

If a high-frequency wave traverses a hollow waveguide the diameter of which is dimensioned to exceed slightly the cut-off diameter, the attentuation in the pipe will decrease rapidly with increasing frequency. Consequently a frequency-modulated wave having a center frequency slightly above the cut-off frequency will acquire amplitude modulation as it passes through the guide. This effect is being made use of in the present invention. Obviously, the resulting amplitude-modulated wave will also be frequency-modulated. However, this is of negligible importance if a crystal detector is used for demodulation.

Preferably and as illustrated in the drawing, the modulating voltage for the ultra-high frequency wave is an intermediate frequency voltage which is, in turn, modulated either as to amplitude or frequency by the signaling voltage.

The frequency modulation may be caused unintentionally by trying to amplitude-modulate a high-frequency wave—the frequency should increase with increasing amplitude —or deliberately by a reactance tube circuit. As any increase in frequency of the waves impressed upon the waveguide decreases the attenuation within the pipe, the waves upon emerging from the waveguide for radiation by the



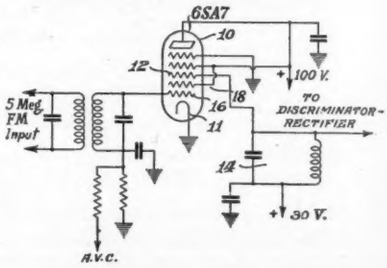
horn antenna have their amplitude modulation increased over any original value. Alternatively, a frequency-modulated wave may be transmitted and converted in the receiver by the insertion of a suitably dimensioned waveguide.

W. van Roberts, RCA, (F) September 25, 1942, (I) January 22, 1946, No. 2,393,414.

Dynatron Frequency-Divider

Frequency division of an FM wave is accomplished by applying the output of an intermediate frequency amplifier of an FM receiver to the control grid 16 of tube 10 and connecting cathode 11, grid 12, and grids 18 to operate as a dynatron oscillator. Tank circuit 14 of this dynatron circuit is tuned to a subharmonic of the center frequency of the frequency-modulated intermediate frequency. The negative resistance presented by the dynatron section of the tube is effectively connected in parallel with the resonant circuit 14 or with a discriminator. Therefore, oscillations at approximately the discriminator center frequency will result, if the impedance of the discriminator is higher than the negative tube resistance.

Since the electron stream causing the secondary emission from grid 12 is controlled by the FM voltage on grid 16, the FM wave energy will be effective in locking in the oscillations. Due to the self-biasing action of the input grid 16, the electron stream will pass this grid only during the most positive portions of the applied intermediate frequency wave. Therefore, the negative resistance of grid 12 will be effective during short periods of each intermediate frequency cycle. The phase of the current pulses, when the intermediate frequency is an exact multiple of resonant frequency of circuit 14, will bear a definite relation to the phase of the current in this resonant circuit. If the intermediate frequency deviates from this value, the phase of the current in circuit 14 will be shifted in such a way that over a limited range, the oscillations of the tuned circuit will be maintained at the same submultiple of the instantaneous intermediate carrier frequency.



It will be seen that the dynatron oscillator will lock in with the exact submultiple of the instantaneous intermediate frequency, thereby providing frequency division proportionately reducing center frequency and frequency deviation by the same factor.

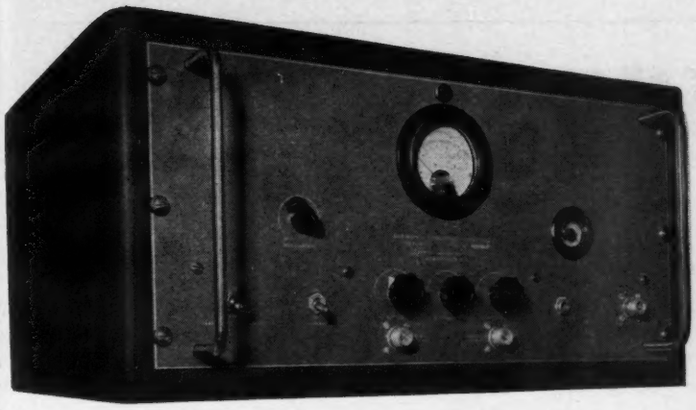
W. R. Koch, RCA, (F) June 15, 1942, (I) February 26, 1946, No. 2,395,746.

HF Amplifier

The amplifier described operates satisfactorily over a wide frequency range and is provided with an input electrode system 43, 44, 45 which reduces input losses at extremely high frequencies to a minimum. The electron stream emitted by the electron gun 42 will contain electrons of slightly varying velocities; the velocity spread may be equivalent to an accelerating voltage in the order of one volt. Consequently it is feasible to fix the potential of the electrode 45 to a value such that the retarding field which it produces reverses about half the approaching electron beam. If the potential of the electrode 45 is varied slightly from this value, the relative magnitudes of the reversed and transmitted beam portions will be modified accordingly. This change in transmitted beam intensity may be large for small shifts in electrode potential. Beam density modulation is secured by

(*Continued on page 98*)

*A similar scheme for the demodulation of frequency modulated pulses is described in an article by J. Zwislocki-Moscicki, summarized on page 80 of this issue.



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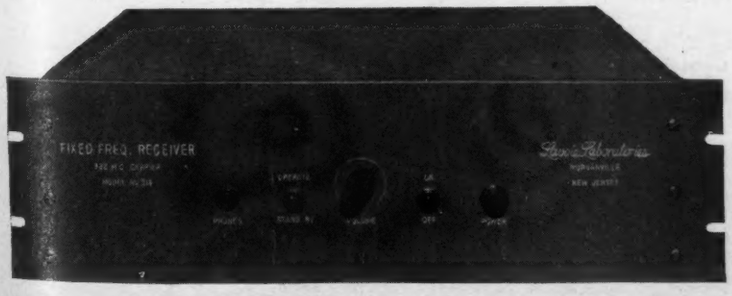

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NEWS OF THE INDUSTRY

FCC to Amend Rules For FM Broadcasting

The Federal Communications Commission proposes to amend certain of its Rules and Standards concerning FM broadcasting. The proposed changes are designed to simplify the allocation and assignment of facilities in this service.

The three previous classes of FM broadcast stations would be reduced to two: Class A (formerly designated as Community) and Class B (including the former Metropolitan and Rural Classes). The 20 Class A channels are designed to render service primarily to a Community or to a city or town other than the principal city of an area, and surrounding rural area. The 60 Class B channels are designed to render service primarily to metropolitan districts or principal cities and surrounding rural area, or to rural areas removed from large centers of population.

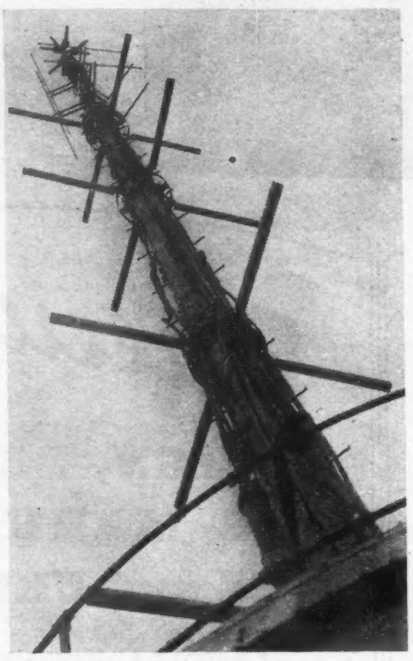
Stations in the Community class are now limited to 250 watts of effective radiated power with 250 ft. antenna height; the proposed rule for Class A stations provides a coverage equivalent to a minimum of 0.1 kw and a maximum of 1.0 kw effective radiated power with the same antenna height. The minimum mileage separation specified for Class A stations would be the same as now specified for Community stations.

The present rule states that service areas will be designated by the Commission for Metropolitan stations in Area II and appropriate power and antenna height will be authorized. Under the proposed rule, a range of power and antenna heights are provided for Class B stations within which the appropriate values may be requested by applicants.

For the purpose of allocation, the proposed rules divide the United States into two areas as at present.

It is contemplated that the tentative allocation plan for Metropolitan (and Rural) FM stations announced in December 1945, would continue to be followed in the assignment of Class B stations. No allocation plan is being proposed at this time for Class A stations.

Ten channels (from 106.1 to 107.9 Mc) are not now available for Community stations in Area II. The proposed rules provide for 20 Class A channels in both Area I and Area II, and no channels would be specifically reserved for facsimile. However, it is proposed that facsimile transmission would be authorized on any channel, whether Class A or Class B, in both Area I and Area II.



Atop Empire State building, New York, NBC's new television antenna is an array of 16 elements, used for both video and sound (66-72 mc). Two other antennas on same mast (1250 ft. above street level) serve for FM and for experimental television on 288 mc, respectively

RMA Holds Seminar on Labor Bargaining

What the radio industry needs in so far as labor is concerned is more skillful negotiators and a better knowledge of employer-labor relations. That, in brief, was the keynote of the two-day Industrial Relations Seminar, conducted in New York, May 21-22, by Radio Manufacturers Association, first meeting of its kind to be carded. About 150 industrial relations and personnel managers attended.

CBS Licenses Federal

Columbia Broadcasting System has licensed its second organization to produce color television equipment under the Columbia patents. The new licensee is Federal Telecommunication Labs. Inc. affiliate of the International Telephone & Telegraph Corp. Both this company and the previously licensed Westinghouse Electric Corp. will operate on a patent royalty basis covering a five year period.

McQuay-Norris Adds

McQuay-Norris Mfg. Co. has purchased the buildings and equipment of the L. M. Persons Corp. and the Southern Electronics Co., both St. Louis, Mo. These companies manufacture electric controls and other electrical devices, and henceforth will be known as the Electric Products Division of the parent company. L. M. Persons and other personnel will remain with the division.

Conventions and Meetings Ahead

American Physical Society, (Karl K. Darrow, Secretary, Columbia University, New York); July 12, 13, Berkeley, Calif.; Sept. 19-21, New York, N. Y.

American Institute of Electrical Engineers (H. H. Henline, 29 W. 39th St., New York); Pacific Coast Convention, Aug. 26 to 30, Seattle; Great Lakes District Meeting, September 26-27, Fort Wayne, Ind.

American Chemical Society (Alden H. Emery, 1155 Sixteenth Street, N.W., Washington, D. C.); September 9-13, Chicago, Ill.

Instrument Society of America (Chairman of the Exhibit Committee, Paul Exline, P. O. Box 2038, Pittsburgh 30, Pa.); 1946 Exhibit and Conference, Sept. 16 to 20, Pittsburgh, Pa.

American Society of Mechanical Engineers (Ernest Hartford, 29 W. 39th Street, New York, N. Y. PE 6-9220); Sept. 30 to Oct. 3, Boston, Mass.

National Electronics Conference, Oct. 3, 4, 5, Edgewater Beach Hotel, Chicago.

Television Broadcasters Association, Inc., (500 Fifth Avenue, New York 18, N. Y. Room 1038, Will Baltin, Secretary); Conference October 10 and 11, Waldorf-Astoria Hotel, New York City.

Electronic Exhibitors (Harry G. Cisin, Executive Director, 50 Broad St., New York) Grand Central Palace, New York, Oct. 14-19, Electronic, Radio and Television Exposition.

Electrochemical Society (Colin G. Fink, Columbia University, 3000 Broadway, New York, N. Y. UN 4-3200); Oct. 16-19, Toronto.

American Welding Society (Miss M. M. Kelly, 29 W. 39th St., New York, N. Y. PE 6-9220); Annual meeting, Oct. 24, New York City and Nov. 17 to 22, Atlantic City, N. J.

Institute of Radio Engineers, (Wm. C. Copp, 303 West 42d Street, New York); Annual Meeting (Commodore Hotel) and Show, (17th Regiment Armory) New York, March 3-7, 1947.

NO CROWDING, PLEASE!

Everyone can see!

DU MONT 15AP4 offers a picture 9" x 12" PLUS

BIG NEWS! A large screen television receiving tube with all the advantages of direct viewing—high picture definition and more than adequate brightness for demonstrating under usual showroom lighting conditions. Measures *only* 20 inches long to permit graceful cabinet design.

OTHER IMPORTANT FEATURES...

1. Essentially flat face
2. 7.5 – 10 KV anode supply
3. All-magnetic deflection and focusing
4. No ion trap

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WASHINGTON

Latest Electronic News Developments Summarized by Electronic Industries' Washington Bureau

HEADACHES AND STILL HEADACHES—With pricing relief achieved, radio receiver and transmitter production still is slowed up by other headaches. Like all American industry, radio manufacturers have been dislocated by the recent railroad and coal mining strike situations and prior to that by the steel production cessation. But, just as important, is the short supply of copper, the worst in June since the war emergency "red metal" shortages, and the lack of lumber for radio cabinets. Because of these obstacles, the outlook at the mid-year was that production during the remainder of the summer would stay at its present level of about 1 million sets a month. With the lack of wood cabinets, consoles which embody FM and television are being badly delayed reaching retailers. Naturally, too, manufacturers are aiming toward satisfying the public demand with AM receiver replacements because of the paucity of FM broadcasting stations on the air.

MAJOR FACTORS DELAYING FM STATIONS' OPERATIONS—Three major factors are obstacles in the path of FM broadcasting stations going on the air. FCC, while granting conditional construction permits, has slowed up building of stations through exacting technical requirements, especially on antenna heights. Delay in transmitter manufacturing is another hurdle and present outlook is that only low-power transmitters will be available until fall and even later. Petrillo's ban on FM stations using duplicate transcription musical programs of standard AM stations and proposal to prohibit all recorded music on the radio is felt to be stiffest blow.

AVIATION GROUPS BLOCK FM AND TELEVISION STATION PROGRESS—Serious obstacles in the development of television and FM broadcasting stations, together with radio relay services, in connection with antenna heights and station locations have occurred because of the policy of the Civil Aeronautics Administration in consulting with two private organizations, the Air Transport Association and the Air Line Pilots' Association. This consultation activity, in view of the generally adamant opposition of the ATA and pilots' group to high antennas, has aroused resentment in the radio industry. The problem will grow more serious with the implementation of construction of around 3,000 new airports under the Airport Bill, just placed on the statute books by President Truman.

FACSIMILE STANDARDS LIKELY IN JULY—FCC expects to receive from the radio manufacturing industry as represented by joint committee of RMA and RTPB during July the postwar engineering standards for facsimile broadcasting. Full agreement has been reached by two principal Fax equipment manufacturers, Finch and Hogan, and, when standards are submitted by industry to FCC, Commission action is regarded as virtual formality, possibly without hearings. Facsimile production will get under full speed this fall, it is anticipated. Many major newspapers are interested in the service and two leading papers—Chicago Tribune and Detroit News—have started Fax broadcast newspaper service. FM broadcasting stations engaging in Fax broadcasting also are increasing in number. In fact, Facsimile, as has been predicted before in this column, is definitely shaping up as the "sleeper" of the new radio services.

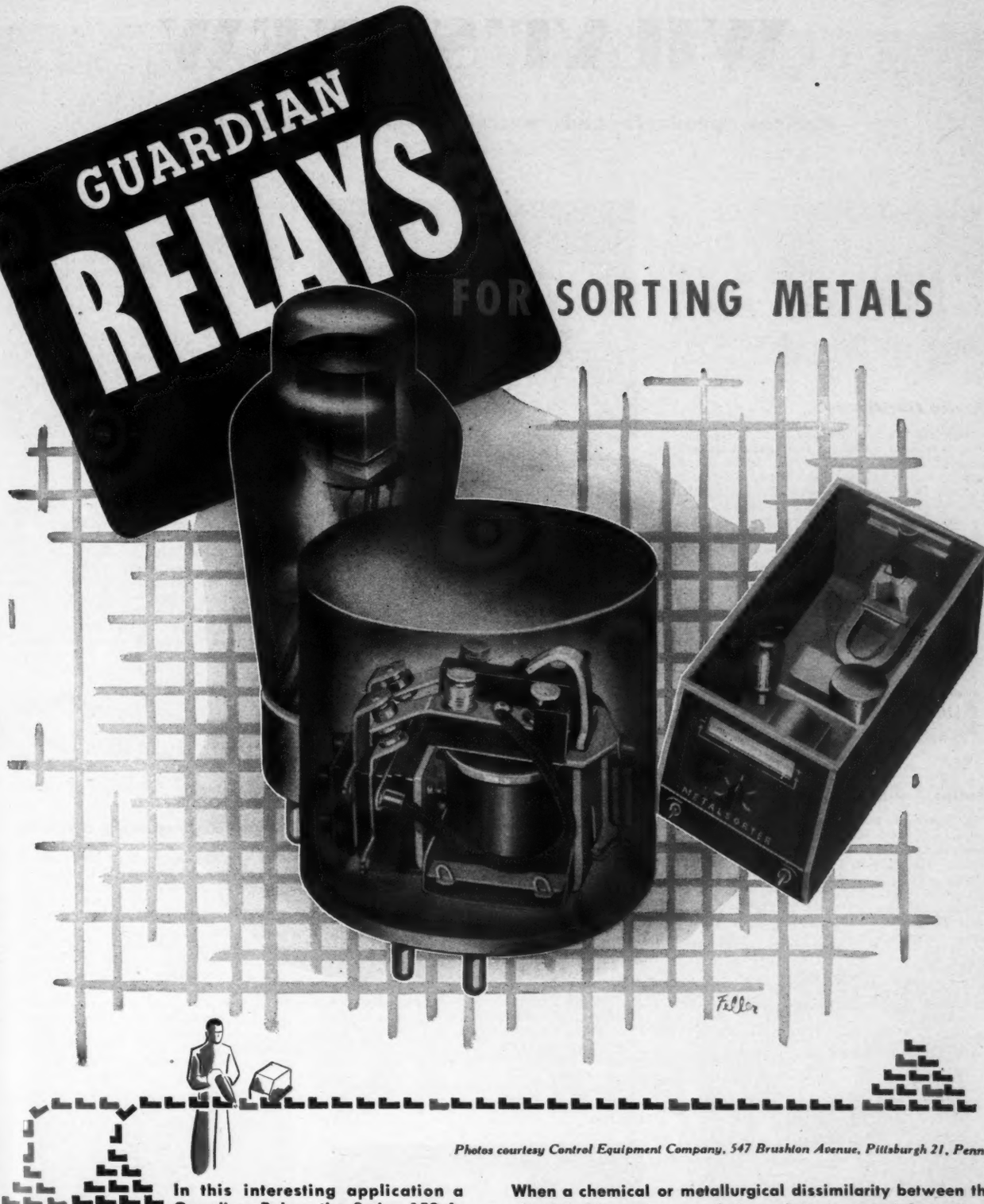
RMA WASHINGTON HEADQUARTERS DESERVES CREDIT—The mid-June annual convention of the Radio Manufacturers Association in Chicago recognized valuable work of RMA Executive Vice President Bond P. Geddes and his chief aide, Director of Publications James D. Secrest, in keeping the industry closely and promptly advised of developments on the many fronts of OPA, CPA, labor, surplus, etc. Association chieftain Geddes actually deserves full commendation of industry for his recent move in bringing about issuance of OPA receiver price order. It had been held up for weeks in OPA staff circles, but Mr. Geddes asked OPA Administrator Paul A. Porter, former FCC Chairman, to investigate the situation and Porter had the price increase order promulgated within a few hours. RMA headquarters also aided the industry in securing priorities for critical materials—as an example, "spider-cloth" for loudspeakers, the manufacturers of which were about to close down production due to lack of this textile component. The Washington headquarters, likewise, promoted the recent highly successful industrial relations seminar, the first staged by the RMA.

MISCELLANY—Navy Bureau of Ships' Electronics Division and Army Signal Corps are stressing increased research under 1947 fiscal year appropriations . . . Interstate Commerce Commission has responsibility of encouraging railroad use of radio, FCC Safety and Special Services law chief Jeremiah Courtney stresses . . . Important test case on future operation of bus-truck-taxicab mobile radiotelephone operations staged in early June hearing of FCC, designed to weigh advisability of separate mobile industry communications agencies against telephone companies.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

GUARDIAN RELAYS FOR SORTING METALS



Photos courtesy Control Equipment Company, 547 Brushton Avenue, Pittsburgh 21, Penna.

In this interesting application a Guardian Relay, the Series 150-A, regulates the duty cycle of a Thyratron tube to control the time involved operating a testing tool for metal sorting.

Unit shown is the Metalsorter which employs the tribo-electric effect on metals, steel and non-ferrous alloys. The principle is simple. An acceptable or standard metallic specimen is placed in the holding chuck of a reciprocating tool, and the test is made by rubbing the standard against the unknown for a controlled time.

When a chemical or metallurgical dissimilarity between the chuck-held specimen and the unknown material occurs, a minute electrical current is generated and registered by an indicator on a calibrated dial. If the metals are alike, there is no current flow. Consequently, the operator is enabled to quickly identify, sort, or accomplish non-destructive testing of each item.

Again the association of a Guardian Relay and an electron tube solves an intricate control problem.

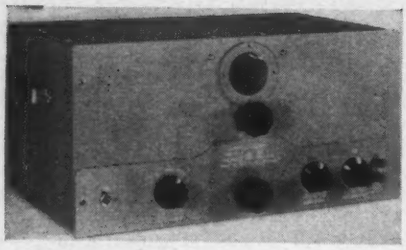
GUARDIAN ELECTRIC

1622-H W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

WHAT'S NEW

Devices, products and materials the manufacturers offer

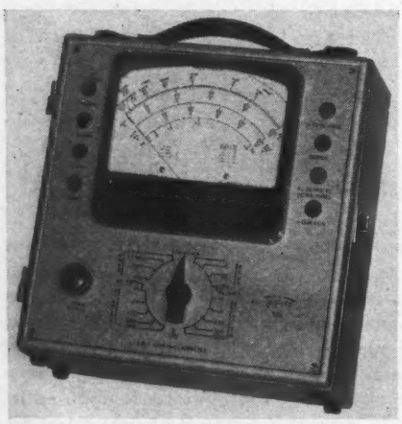


Audio Oscillator

Hewlett Packard Co. Inc., Palo Alto, Cal., has developed an audio frequency oscillator capable of delivering 3 watts power output into a 600 ohm resistance load. Frequency control is effected by a 6 in. dial, which may be directly controlled or by means of a vernier, which has a ratio of 6 to 1 to the main dial. The unit has a frequency range from 20 cps to 20 kc and a distortion of less than ½% at 1 watt output.—Electronic Industries

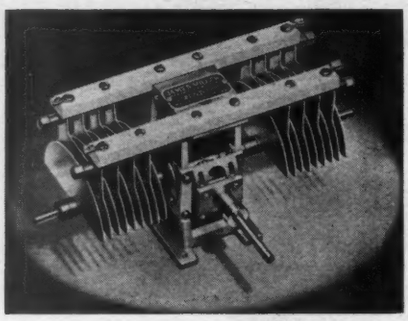
Radio Telephone

A compact transmitter-receiver for low power radio telephone applications is being manufactured at the Erco Radio Laboratories, Hempstead, Long Island, N. Y. Power output is 18-22 watts in the 3 to 6 mc. band. The transmitter, pretuned and crystal-controlled, is available for 6, 12, 32, volts dc. or 110 v. 50/60 cycle ac.—Electronic Industries



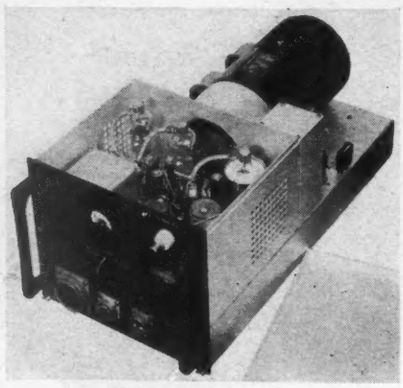
Volt-Ohm-Milliammeter

A volt-ohm-milliammeter having a sensitivity of 25,000 ohms per volt on dc ranges is one of a line of test instruments recently brought out by Triplett Electrical Instrument Co., Bluffton, Ohio. The instrument provides 10 ac and dc current and voltage ranges, four resistance ranges and permits decibel readings from —10 to +55 db. The model 2405 has a 6 in. square dial.—Electronic Industries



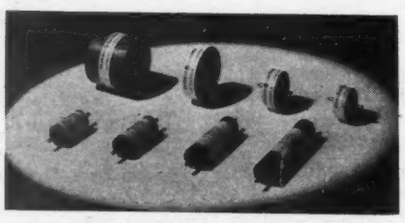
Transmitting Capacitors

The 04000 series of transmitting variable air capacitors has recently been brought out by James Millen Mfg. Co., 150 Exchange St., Malden, Mass. The capacitor has a constant impedance, heavy current, multiple finger rotor contactor of novel design and is available in peak voltage ratings of 3000, 6000 or 9000 volts.—Electronic Industries



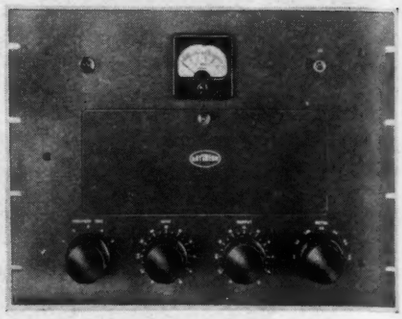
Plane Transmitter

A 100 watt aircraft transmitter for 3105 kc and 6210 kc voice operation, designed especially for executive type planes, is being manufactured by Collins Radio Co., Cedar Rapids, Iowa. The 17E-2 transmitter weighs 44 lbs, including power supply, and is remotely controlled. All circuits are pretuned. The transmitting frequency is selected by a single switch—Electronic Industries



Television Capacitors

A line of small light-weight capacitors designed for smoothing the high voltage power supply and meeting special mounting requirements in television receivers is being manufactured at General Electric, Schenectady, N. Y. These Lectrofilm units are available either in flat cylinder or tubular construction and are rated .005 mfd, 5,000 to 16,000 volts.—Electronic Industries

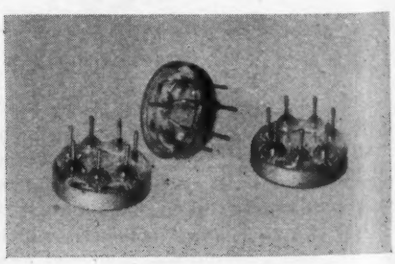


Volume Limiter

A volume limiter, which will raise the average percentage of modulation without audible increase in harmonic distortion has been brought out by the Raytheon Mfg. Corp., Waltham, Mass. With a compression of 5 db. the distortion is held to less than 1% and an input variation from —40 to +20 db. can be handled. Designed for high-fidelity am and fm systems, the limiter has a frequency response from 30 to 15,000 cycles.—Electronic Industries

Sound Reproducing System

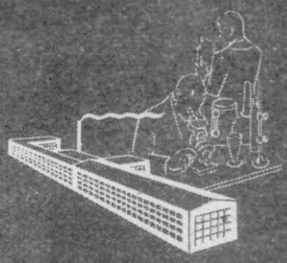
A reproducing group for radio broadcasting and for sound distribution systems, which is designed for high stability and reproduction quality, is available from Western Electric Co., 195 Broadway, New York. The group includes a combination lateral-vertical reproducer, a reproducer arm and accessories. Two vertical and five lateral reproducing characteristics are provided by means of switching. The overall frequency response is better than 10,000 cps. A combined equalizer and matching device is designed to work into input impedances of 30, 250, 500 or 600 ohms.—Electronic Industries



Electronic Glassware

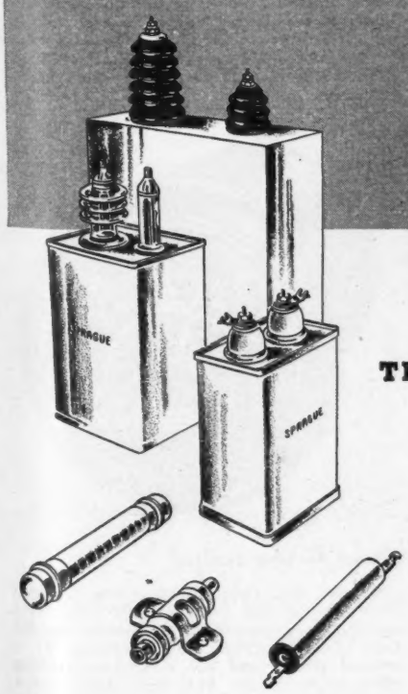
In the series of metallized electronic glassware recently brought out by Corning Glass Works, Corning, N. Y., headers, which are designed to accommodate multiple leads, overcome some of the problems in design and assembly. These headers can be furnished with or without metallizing, depending whether hermetic sealing of the unit is required—Electronic Industries

• PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS •



THE MAJOR CAPACITOR AND WIRE-WOUND RESISTOR DEVELOPMENTS OF THE PAST 5 YEARS HAVE BEEN ENGINEERED *by*

SPRAGUE



THEY INCLUDE:

***VITAMIN Q** impregnated capacitors for higher voltages, higher temperatures and higher insulation resistance.

•

***HYPASS 3-TERMINAL NETWORKS** that set new standards of performance in solving anti-resonant frequency problems at frequencies as high as 150 megacycles or more.

•

GLASS-TO-METAL hermetically-sealed capacitors fully proofed against leakage, moisture, fungus, corrosion and shock.

ENERGY STORAGE capacitors of greatly increased capacity in smaller physical sizes.

•

MEGOMAX high-resistance, high-voltage resistors. Megohms of resistance operated at thousands of volts.

•

SPRAGUE *KOOLOHM RESISTORS with glazed ceramic coating and new type end seals in one standard type for use under any climatic condition.

•

Catalog of any type on request

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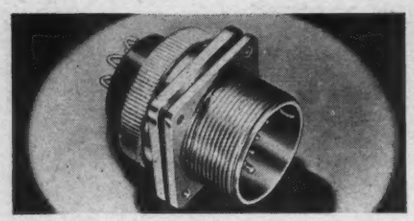
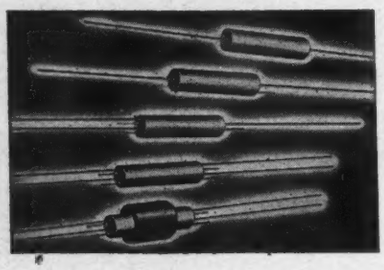
SPRAGUE ELECTRIC CO., NORTH ADAMS, MASS.



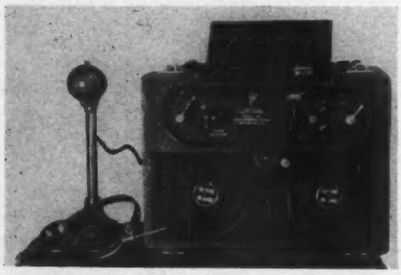
Cable Connector

Available in either pressurized or non-pressurized types, a new cable connector made by H. H. Buggie & Co., Toledo, Ohio, includes tubular ceramic capacitors for by-passing each pin. Capacities from 50 to 1800 mmf assembled within the connector shell provide unwanted frequency filtering. A full line of connectors with various capacities and voltage ratings will be built.—Electronic Industries



Molded Coil Forms

Molded bakelite coil forms with anchored "hairpin" wire leads, which are being manufactured at Stackpole Carbon Co., St. Marys, Pa., may be used for universal or tapped windings, solenoid windings, antenna or coupled windings, iron core coupled and iron core universal windings and many others. Standard types are available with coaxial leads, single and double hairpin leads.—Electronic Industries

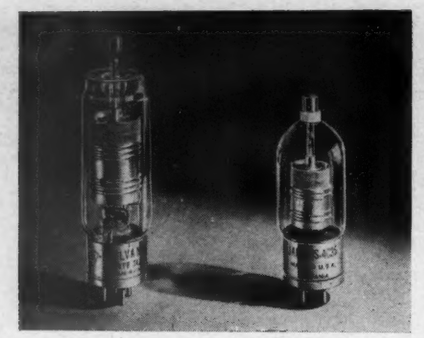


Film Recorder

A sound-on-film recorder of the embossing type, which provides one hundred sound tracks across the width of the film, each lasting approx. 20 minutes is being manufactured at the Miles Reproducer Co., 812 Broadway, New York. The Filmgraph Model HM uses an electro-magnetic head with a diamond pointed stylus for both recording and reproduction. Accurate indexing of the reels is by means of a numbered dial showing the track number and a footage counter giving the beginning and ending of each recording.—Electronic Industries

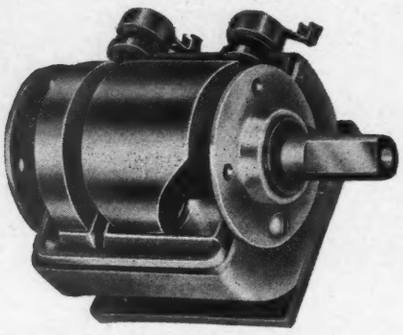
Glass Schmidt Lenses

For use with television receivers operating on the Schmidt projection system, American Optical Co., Southbridge, Mass., has brought out complementing mirrors and lenses made of glass. Both are molded, then ground and polished to a degree of accuracy which corrects for aberrations resulting from the normally slightly curved face of the cathode ray projection tube.—Electronic Industries



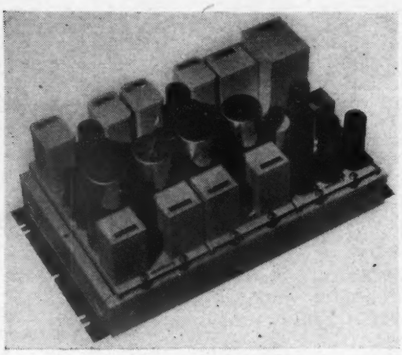
Hydrogen Thyratrons

Two hydrogen thyratrons for use in pulse communication, high speed welding, electroplating, electro surgery and high speed photography have been brought out by Sylvania Electric Products Inc., 500 Fifth Ave., New York. Low deionization time, rapid switching rates, high peak currents, high plate voltages and moderate trigger requirements are some of the characteristics.—Electronic Industries



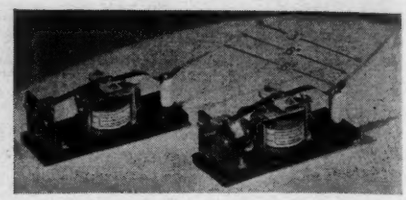
Variable Capacitor

"Cam-Rotor," a variable tuning capacitor having greater electrical efficiency by use of a fluid dielectric than many present types and that is designed to eliminate acoustical feedback has been developed by Timing Instrument Co., 106 Spring St., New York. The unit has solid barrel-cam rotors with only one moving part per stage and is interchangeable with standard RMA types and variable air-gap capacitors.—Electronic Industries



Multi-Channel Amplifier

A dual-channel fixed medium gain preamplifier, which will allow considerable saving in cabinet and rack mounting space, has been brought out by Langevin Co., 37 W. 65 St., New York. Designed for high quality audio systems, each channel of the amplifier operates from a source impedance of 30, 250 or 600 ohms into a load impedance of 600 ohms. Output power is .038 watts and frequency characteristic is flat from 30-15,000 cps, ±0.5 to 1 db.—Electronic Industries



Antenna Switchover Relays

A series of hf relays for antenna switchover, heating, X-ray and other hf industrial applications for either ac or dc use has been developed by Leach Relay Co., Los Angeles, Cal. The new type design provides each contact pole with a separate coil and base permitting any spacing between silver contacts. The relays are designed to withstand over 4000 volts rms., 60 cycle ac between contacts and between frame, ground and contacts.—Electronic Industries

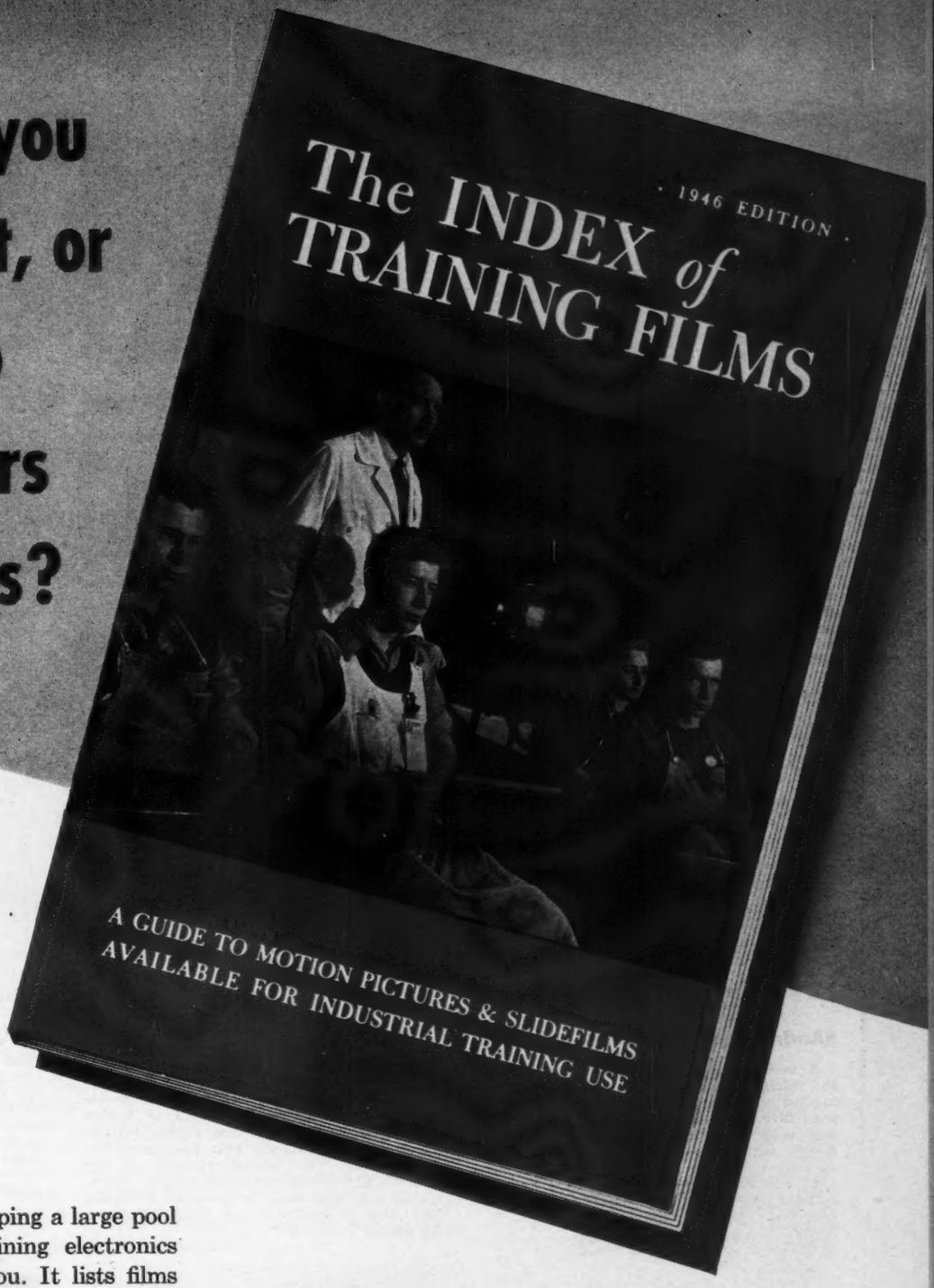
Laboratory Test Unit

A volt-ammeter manufactured at Reiner Electronics Co., 152 W. 52nd St., New York, provides for manual connection of shunts and multipliers thus permitting greater than usual flexibility of ranges. A built-in drawer holds a supply of fuses, coded shunts and multipliers accurate to 1% for a range from 1 to 1000 volts and 2.5 ma to 10 amps. The meter is a hermetically sealed unit.—Electronic Industries

Time Delay Relay

Cramer Co., Centerbrook, Conn. is manufacturing a line of TEC-TER time delay relays, which provide an adjustable or fixed time delay between the operation of a control circuit and the closing or opening of a load circuit. The time delay relays are equipped with an electro-magnetic clutch which permits resumption of the normal starting position when control or power circuits fail.—Electronic Industries

Where can you borrow, rent, or buy films to train workers in electronics?



Here's the book that will tell you. It's new. It's *free.* Write for a copy!

IF YOU ARE INTERESTED in tapping a large pool of "*ready-made*" films for training electronics workers, this book will help you. It lists films available from scores of manufacturers, film distributors, and government bureaus.

It classifies and describes 155 outstanding training films on electronics and related subjects . . . 1545 in other fields. You'll find films for training production workers, salesmen, maintenance men, "trouble shooters". . . covering theory, tubes, circuits. You'll find films on both communications and industrial equipment.

The book tells you where to get them . . . which are free . . . which can be rented or bought, and what they cost.

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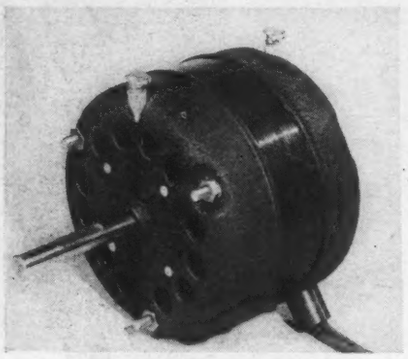
Kodak

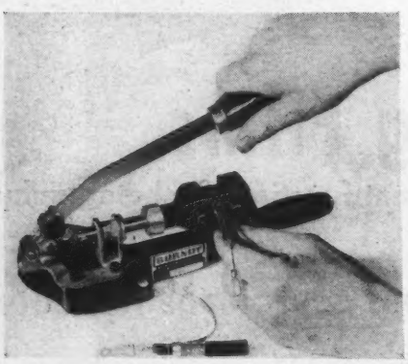
Trimmers

Madison Electrical Products, Madison, N. J., has brought out a series of trimmers and padders with uniform capacity variation. These units have low moisture absorption and high mechanical and electrical stability. All standard capacities are available.—Electronic Industries



Shaded Pole Motor

A new design shaded pole motor adapted to refrigeration, heating and ventilating applications has been brought out by Alliance Mfg. Co., Alliance, Ohio. The unit is a 6 pole induction type motor of shaded design with a top speed of approx. 1000 rpm at full load and a rating of approx. 1/30 HP. It operates on 220 volts or less, 50-60 cycles ac.—Electronic Industries

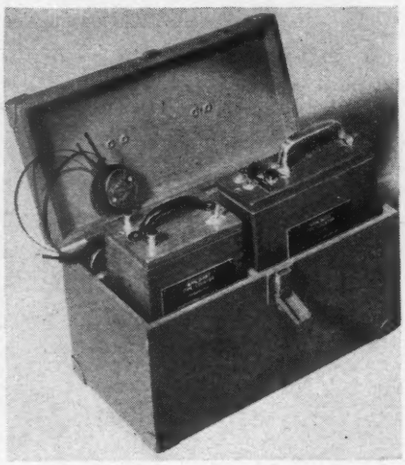


Lug Connector

A portable, manually-operated lug connector, the Hytool, for installing coaxial and shielded cable connectors as well as standard types has been brought out by Burndy Engineering Co., New York. The tool will accommodate all standard die sets designed for use with the foot-operated "Hytool" and the power-actuated "Hypress," two recently developed companion tools.—Electronic Industries

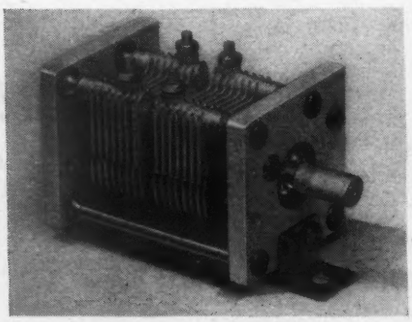
Capacitance-Resistance Bridge

The model 904 resistance-capacitance bridge, developed by McMurdo Silver Co., 1240 Main St., Hartford, Conn., will measure resistances from 10 ohms through 1000 megohms in four ranges and capacitances from 10 mmfd through 1000 mfd, also in four ranges with an accuracy of 3%. Sensitivity control of null indication is provided. The unit consumes 35 watts at 105/125 volts, 50/60 cycles ac.—Electronic Industries



Pipe Locator

The "Wahlquist" pipe locator for locating and determining the depth of buried pipes has been brought out by the Nilsson Electrical Laboratory, 103 Lafayette St., New York. The locator consists of the model 112 transmitter and receiver units, which are contained in portable cabinets. The unit is compact and light weight.—Electronic Industries



VHF Capacitors

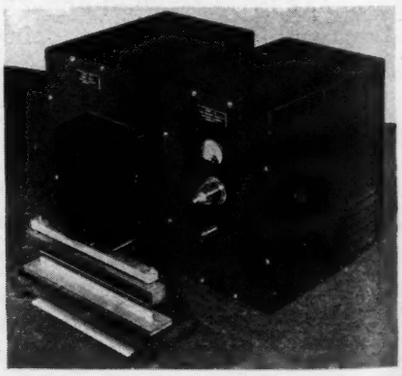
For circuits operating as high as 500 mc a series of capacitors has been designed by Hammarlund Mfg. Co., Inc., 460 W. 34th St., New York. Sliding or wiping contacts are eliminated through the use of pyrex ball bearings. Elimination of the rotor contact precludes the possibility of noise and permits a more symmetrical design. The units are tested for 700 volts, 60 cycle ac. —Electronic Industries

Electrolytic Capacitor

The type ETW capacitors supplied in molded bakelite casing are for motor starting applications and are made by Cornell-Dubilier Electric Corp., South Plainfield, N. J. Capacities range from 25 to 450 mfd in four container sizes supplied with two types of brackets. Bakelite casing provides better insulation, electrical and atmospheric protection than conventional containers.—Electronic Industries

Automatic Dehydrator

An automatic self reactivating dehydrator, which requires no attention and maintains a constant pressure of 15 lbs., has been developed by Andrew Co., 363 E. 75th St., Chicago 19. The unit consists of a motor driven air compressor which feeds one of two cylinders containing a chemical drying agent. Power consumption is 210 watts during normal operation and 320 watts during reactivation.—Electronic Industries

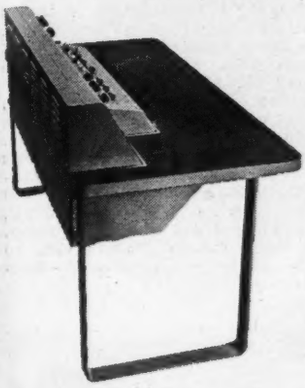


Electronic Welder

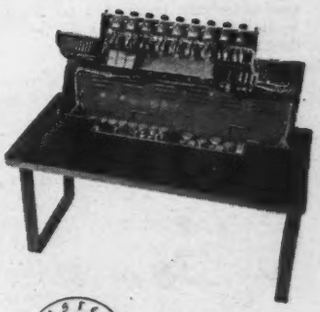
The electronic "Weld Seal" equipment can weld or heat seal a variety of plastics and can also be used for bonding precoated callendered or laminated thermoplastic materials with cloth, Vinyl, etc. The welder has been developed by the Electronic Process Corp., 6 Franklin Ave., Ridgewood, N. J., and is available for 110 or 220 v single phase ac, consuming approx. 1400 watts at full load.—Electronic Industries

from every angle...
IT'S A HONEY!

Western Electric
25B speech input console



It's got sparkling eye-appeal—that's the first thing you'll like about this new audio unit designed by Bell Laboratories. When you see how completely it opens up for inspection and maintenance—almost as easily as turning the pages of a book—you'll like that too. And when you study the list of operating advantages it gives you at moderate cost, you'll agree *it really is a honey!* Ask your nearest Graybar Broadcast Equipment Representative for *all* the the facts about this pacesetting 25B.



Look at these features:

Neat modern styling.

Complete unit design—including table and NEW plug-in cables.

Uniform, noise-free, distortionless operation over a 15,000 cycle range.

8 low level microphone channels and 3 line level channels. Any 4 microphone channels and three line level channels—7 in all—can be used simultaneously.

2 high quality main amplifier channels that handle 2 programs simultaneously—plus separate monitor and cueing channel.

7 remote line input circuits—3 normalled through for program transmission or sending or receiving cue.

All controls arranged and coordinated for maximum operating flexibility and convenience.

Compact—only 36" high, 55¼" wide, 28¾" deep.

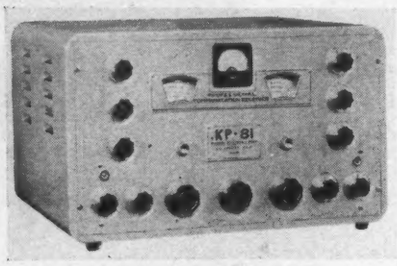
Designed for maximum ease of installation—junction boxes supplied.

Completely wired for easy plug-in connection.

All parts readily accessible for inspection and maintenance.

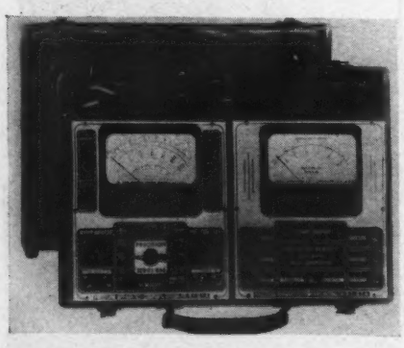
High Power Loudspeaker

The model B-6 loudspeaker, a rugged unit capable of withstanding the 250 G shock test and with a power handling capacity of 150 watts for large outdoor installations, public utilities, airports, etc., has been brought out by University Laboratories, 225 Varick St., New York. The speaker has a slightly rising frequency characteristic from 200 to 6000 cycles and a distribution angle of 90°.—Electronic Industries



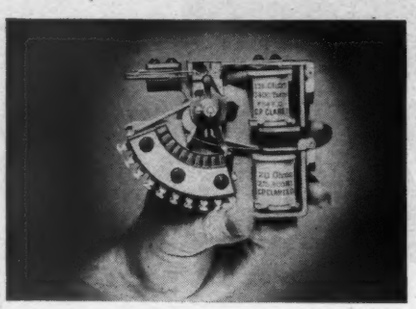
Communications Receiver

Pierson Electronic Corp., Los Angeles, Cal. has developed model KP-81 communications receiver designed for professional and amateur operators. The receiver has 18 tubes including 2 stages of rf preselection, 3 if stages, noise limiter with automatic threshold control, squelch circuit and 12 watt output stage. Five bands cover a frequency range from 550 kc to 40 mc. Crystal filter, sensitivity control and other standard features are provided. The unit is available for 110 or 220 volt, 50-60 cycle operation. —Electronic Industries



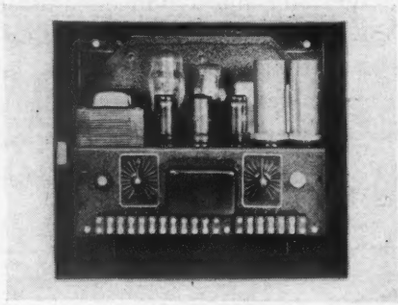
Industrial Circuit Tester

A portable multi-range ac-dc industrial circuit tester, Series 856-J has been designed by Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, N. Y. The portable combination provides for a selection of 52 ac-dc voltage and current ranges for use in industrial, electric power, laboratory testing and analysis. The basic meter has a 50 microamp. movement and calibration is provided at both 1000 ohms and 20,000 ohms per volt. The combination makes possible simultaneous measurements of ac currents and voltages.—Electronic Industries



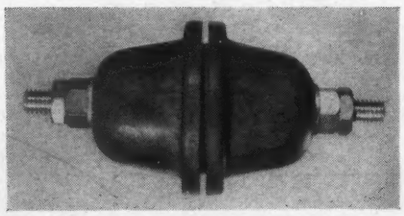
Selector Switch

A high-speed multiple-contact switch for the selection of any of ten channels is being made by C. P. Clare Co., 4719 West Sunnyside Ave., Chicago 30, Ill. The direct drive stepping switch with reset magnet is supplied with one, two or three bank levels and at 48v has an operating speed up to 35 steps per second with a release time of 0.03 seconds. Units are available for nominal voltages of 6, 12, 24 and 48.—Electronic Industries



Registration Control

A high speed registration control for use on either intermittent or continuous flow high speed wrapping machines is in production at Fisher-Pierce Co., 65 Ceylon St., Boston 21, Mass. A change in light intensity of 1 ft.-candle and of .0001 to .5 seconds duration will operate the unit.—Electronic Industries

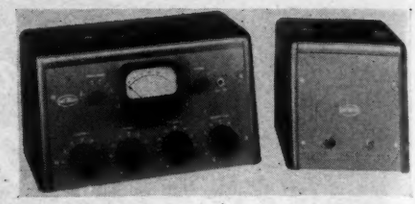


Transformer Bushing

A transformer bushing having less bulk than the conventional types because of superior dielectric properties has been brought out by Electronic Mechanics, Inc., 70 Clifton Blvd., Clifton, N. J. The bushing is Mykroy, a glass-bonded mica ceramic, and is designed for high voltage transformer secondaries used in neon signs, cold cathode lighting, oil burner ignition systems and similar applications.—Electronic Industries

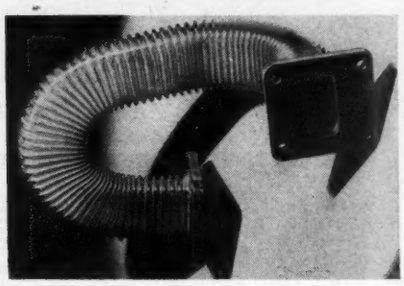
PF. Correction Block

Up to 2 KVA at 230 volts, 50-60 cycles ac are provided by the power factor correction block being manufactured at Tobe Deutschmann Corp., Canton, Mass. The block is constructed of 10 mfd centertapped units and may be connected for either single phase or three phase operation. The sections, which may be removed for load balancing are oil impregnated and hermetically sealed. —Electronic Industries



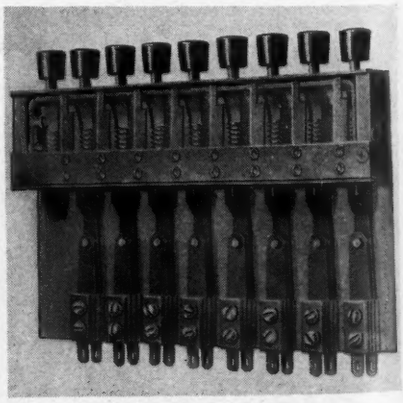
Remote Amplifier

Two types of remote broadcasting amplifiers are now being manufactured by the Raytheon Mfg. Co., Inc., 60 E. 42nd St., New York 17. One provides single channel microphone pickup in a 20 lb. self-contained unit; the other (illustrated) has low level channels for three microphones embodied in two portable cases of 54 lbs. total weight. Both types have identical amplifiers of 96 db maximum gain. At 76 db gain, noise level is —60 db, distortion less than 1½ from 50 to 200 c/s and less than 1% from 200 to 15,000 c/s. Frequency response from 30 to 15,000 c/s is uniform within +2 db. Input channels for either 30 or 250 ohms impedance are available, using either Cannon or Hubbell microphone connectors. Full scale meter ranges are 4, 6, 8 and 10 VU, read on an illuminated 4 in. Weston meter. Both units operate from 110-120 volt, 60 cycle single phase power sources.—Electronics Industries



Flexible Waveguides

Waveguides for operation at wavelengths from 20 to less than 3 cm are being manufactured at American Metal Hose Branch of American Brass Co., Waterbury 88, Conn. Three types of flexible waveguides are available: The "interlocked" type with a molded synthetic rubber jacket, the vertebra type assembly and the seamless flexible waveguide assembly.—Electronic Industries

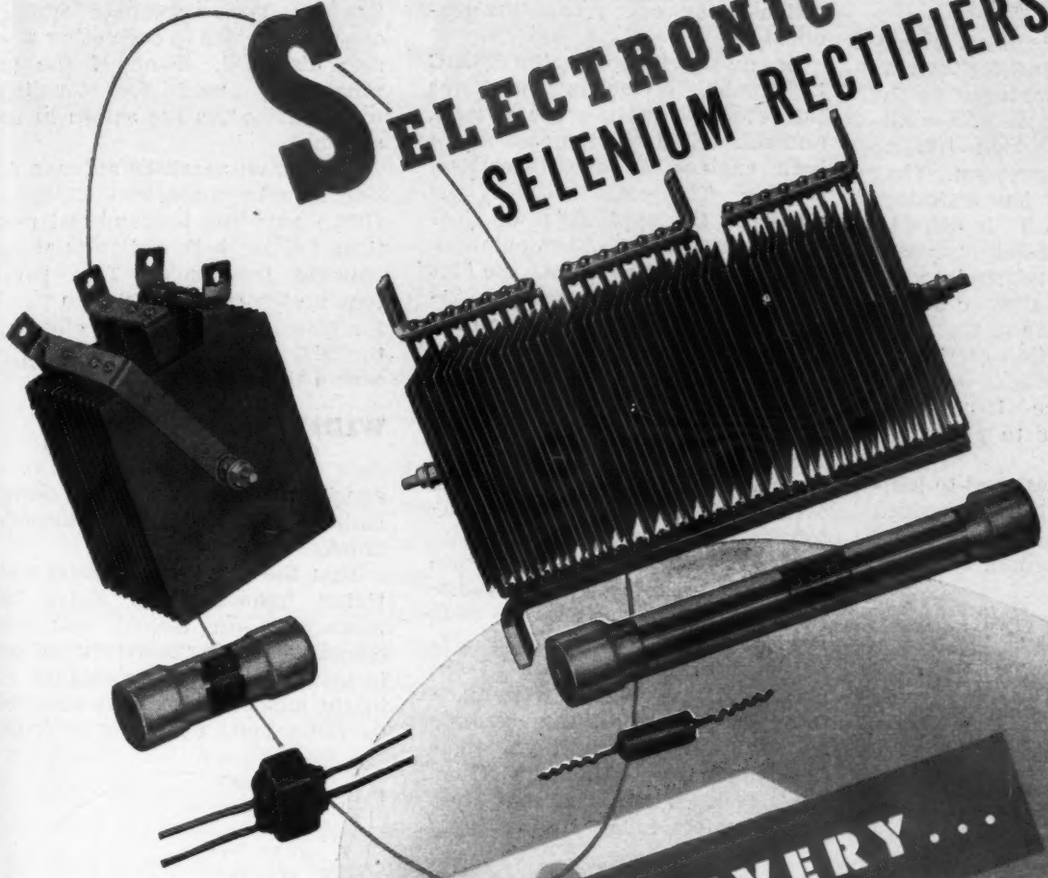


Push Button Switch

A "Master" model MPB push button switch in locking and non-locking frame types with 9 positions, one of which is a reset position has been brought out by General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass. The contacts are silver permanently riveted to phosphor-bronze contact springs.—Electronic Industries

(*Continued on page* 114)

SELECTRONIC SELENIUM RECTIFIERS



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Solve your rectification problems with SELENIUM. SELENIUM rectifiers are rapidly becoming standard in industry. Check these outstanding features:

- ✓ Permanent characteristics.
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SCA

46-B

ENIAC

(*Continued from page 67*)

The function table is an important unit of the ENIAC for the reason that most problems put on the machine involve the use of a mathematical function which has no simple analytical expression. Thus the computation of the trajectory of a shell (see Fig. 9) is done by solving the differential equations of a moving body, taking into account the ballistic drag function, that is, the resistance of the air to the shell as a function of the velocity of the shell. This is the problem the Ordnance Department must solve in order to produce a firing table.

The ENIAC was designed to handle this problem, being provided with three function tables for setting up the ballistic drag function.

$$(a^2 - u^2)\frac{\partial u}{\partial x} - u\,v\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) + (a^2 - v^2)\frac{\partial v}{\partial y} + \frac{a^2 v}{y} = 0,$$

$$\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} = 0$$

Fig. 9—Equation for the motion of air as a sharply pointed projectile moves through it

The actual numbers are set on switches located on the portable function table matrix (see Fig. 1), which can hold the value of the function for 100 arguments (from 0 to 99) by means of resistors connected to various wires by the switches. When the ENIAC needs the value of a function, such as f(67), pulses representing 67 are sent to the function table, and in 1/1000 of a second it will look in the portable function table matrix for f(67) and transmit pulses representing that value of the function.

The high-speed multiplier is at the heart of most ENIAC computing, because the solution of most complicated problems involves a good deal of multiplication. Furthermore, multiplication, being more complicated than addition, requires a longer time. Multiplication by successive additions of two ten-digit numbers would require (at a maximum) nine additions for each digit of the multiplier, and hence ninety addition times.

Since in a typical ENIAC problem, there is one multiplication for every four additions, it is clear that a more rapid method of multiplication is desirable. This is accomplished by the high-speed multiplier, which (by using an electronic multiplication table) multiplies two ten-digit numbers in thirteen addition times, or about 1/400 seconds!

Because of its speed, the ENIAC is capable of solving problems hitherto beyond the scope of man, and this will have repercussions in both engineering and theoretical science. The great speed is the result of the application of electronic technics to computation. Thus it is that the ENIAC, the first electronic computing machine, inaugurates a new era of scientific progress.

IRE-URSI CONVENE

(*Continued from page 77*)

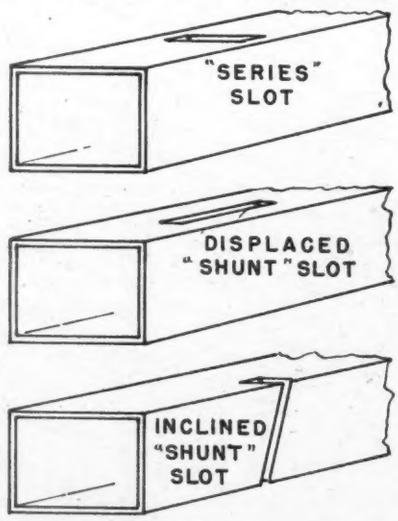
decibel change in input signal level over a frequency range of 25 to 20,000 cycles per second.

A description of the temperature-sensitive resistors used in radiosonde equipment was given by G. L. Davies and Charles B. Pear, Jr., (Washington Institute of Technology). These resistors were made from a semi-conducting ceramic material and have a high negative temperature coefficient. Their characteristics are such that they approximately follow the relation:

$$\frac{R_T}{R_{303}} = \frac{Ce^{\frac{B}{T}}}{T^S}$$

with empirical constants $C = 0.17\ 10^6$, $B = 1306$, and $S = 2.86$.

A method of exciting cylindrical reflectors in the microwave region



Common wave guide coupling methods. (Bell and Bruton.)

directly from rectangular waveguides was discussed by R. E. Bell and D. C. Brunton (National Research Council, Canada). The coupling between the waveguide and the means for radiating a beam was obtained by the use of arrays of slots in the guide. Methods whereby two waveguide systems could be coupled to each other were also discussed. Some of the arrangements used for couplings from waveguides are shown in the sketch.

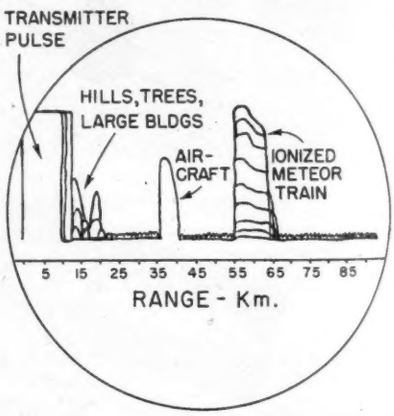
A paper on parabolic antenna design for microwaves by C. C. Cutler (BTL) gave the fundamental relations for parabolic radiators at microwave frequencies. This paper took up the relation between phase for polarization and the effect of the size of the primary radiator within the parabola.

WIDE READING

(*Continued from page 81*)

density "D" and "E" region clouds ionized by high velocity meteoric impact.

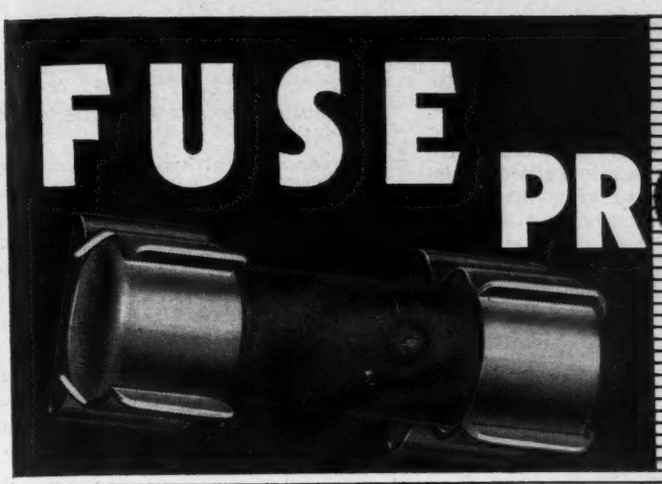
That the limiting or critical scattering frequency lies above 100 megacycles per second, was substantiated when "echo-returns" coincident with the appearance of bright meteor trains were observed on radar units operating in India.



In the figure, the sharp leading edge of the echoes from the airplane and from the ionized layer indicate reflection from well-defined boundaries. The numerous peaks within the echo envelope prove multi-returns from the meteor train. At approximately 105 megacycles per second, echoes were received lasting from ½ to 3 seconds on half-path lengths of 30 to 125 km.

The observation of meteoric impact ionization and the radio effects associated therewith will be greatly aided by the employment of a high-angle radial pattern radar unit operating on frequencies of about 50 megacycles per second. Undoubtedly valuable quantitative information on masses, velocities, and numbers of meteors may be obtained in this fashion.

FUSE PROTECTION



As a built-in component of the newly designed 2 KVA POWERSTAT variable transformers*, the fuse in the output brush contact lead offers economies in set-up time and replacement costs. Needless to say — replacing fuses is decidedly less expensive than replacing POWERSTATS. But . . . instrument protection is not the only new feature of the fused POWERSTATS. User protection is also incorporated. A totally enclosed aluminum terminal box houses all "hot" connections. With the input cord-plug and output receptacle combination, anyone can operate a POWERSTAT without danger of personal injury.

OUTPUT RECEPTACLE

To suit each requirement, the output receptacle is available in a variety of types. It can be supplied to accommodate a two or three wire — straight blade or twist-lock type plug. Connection of the load is a simple matter. There is no bother of clip-leads or direct wiring.

FUSE PROTECTION

Although the fuse has been so selected that the maximum rated current can be drawn at any dial position, it opens the circuit immediately when this value is exceeded. Burned-out coils and ruined brush contacts from overloading are a virtual impossibility. Situated in the recessed bottom portion of the durable cast-aluminum terminal box, the cartridge type fuse can be removed with very little effort. It is protected by a cast-aluminum section which is held in place by screw-connection.

INPUT CORD AND PLUG

Logically, the input cord and plug is a duplication of the output receptacle 2 or 3 wire — straight blade or twist-lock arrangement. In the 3 wire system the 3rd wire is solidly grounded to the POWERSTAT frame. By plugging the cord into a convenient outlet, the POWERSTAT is ready for use.

* Write factory for further details on either terminal stud or fused type POWERSTATS.

Send for Bulletins 1E

THE SUPERIOR ELECTRIC COMPANY

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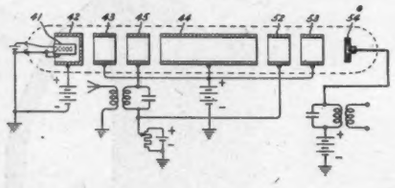
PATENTS

(*Continued from page* 82)

applying a modulating signal to electrode 45.

The input losses of this system are very small. It is argued that the electron transit times from the point of electron reversal to the points of beam entrance and beam exit from electrode 45 are equal, the current leaving the electrode will always be equal to the current entering the electrode. The foregoing consideration will be recognized as important when it is recalled that in conventional systems high frequency input losses are caused by the difference in charges approaching and leaving the control grid and the effect of these charges in inducing currents in the grid circuits.



In the present instance, currents approaching and leaving the control grid are identical and therefore induce equal and opposite charges on the grid which neutralize one another eliminating input losses due to induced grid currents. The modulated electron current may be collected by a positive electrode and employed as desired.

Alternatively the charge density variations may be reconverted into velocity variations and a further stage 44, 52, 53, similar in design and operation to stage 42, 43, 45 may be added. However, electrode 52 has a constant potential negative with respect to electrodes 44 and 53. Electrode 44 constitutes a field-free region within which the charge density modulation of the beam is converted into velocity modulation by the action of the space charge distribution within the beam. The beam is collected by electrode 54. With this system an overall amplification factor of 10 to 20 may be reached. No tuned circuits are required making wide band operation feasible. Detection based on the above-described principle is also explained.

W. C. Hahn, General Electric Co., (F) November 22, 1940, (I) November 27, 1945, No. 2,389,903.

Particle Injector for Accelerator

The charged particles accelerated in a magnetic induction accelerator, first designed by D. W. Kerst, are preferably injected into the orbital equilibrium path at a certain value of the cyclically varying magnetic field. The present invention is concerned with an accessory device to such an accelerator controlling this phase of its operation.

A thin strip of ferromagnetic material which is readily saturated is inserted in the varying magnetic field. Voltage pulses will be induced in a coil wound around this strip only at the instant of reversal of the magnetic field; the exact instant may however be adjusted by the use of a separate coil around the strip carrying constant current and providing a magnetic bias for the strip. The voltage pulses generated in this way will be synchronized with the varying magnetic field and are therefore suitable to control the injection of electrons into the accelerator to take place at a desired point of the magnetic cycle.

W. F. Westnedorp, General Electric Company, (F) June 17, 1942, (I) February 5, 1946, No. 2,394,071.

RELAY TIMERS

(*Continued from page* 51)

seen, the relay sequence will be in-out-in-out-in-out-in, for as many repeated operations as the design permits. In conjunction with a ratchet type of relay, this grid control circuit, operating just one thyratron or vacuum tube, can control an elaborate sequence. As shown in the last figure, the successive intervals are not equal.

The neon tube will break down at slightly different voltages each time, and will extinguish at different voltages each time, and thus affect the intervals t_1 and t_2 by changing E_{3_0}. This is not serious, though, for the intervals are expressible as a function of this type:

$$t = RC \ln \frac{E_{30}}{ef} \qquad (14)$$

where R is a resistance term and C a capacity term. Accordingly, slight changes in E_{3_0} are reflected logarithmically into a change of t_1, which change is therefore relatively small. More specifically,

$$\frac{\Delta t}{t} = \frac{1}{\ln\left(\frac{E_{30}}{ef}\right)} \frac{\Delta E_{30}}{E_{30}} \qquad (15)$$

so the per cent change in "t" due to a change in E_{3_0} is less than the percent change in E_{3_0} by the factor

$$\frac{1}{\ln \frac{E_{30}}{ef}}$$

The greater the ratio of $\frac{E_{30}}{ef}$ the smaller the effect on the timed interval.

Better control with this circuit could be obtained by using a thyratron in place of the neon tube. This would permit a greater breakdown voltage E_{BD}, and a smaller value of tube drop E_T, thus permitting a larger value of E_{3_0}, as can be seen from equation (13).

In a particular application of this circuit, C_1 was replaced by a battery, and the control was used to reverse the current in an arc every minute or so. The battery voltage was 95 volts, with $C_1 = 6$ mfd., $C_2 = 4$ mfd., $R_1 = 40$ megs. and $R_3 = 10$ megs. A 50-second "thyratron off" and 58-second thyratron "on" sequence was obtained, with $\pm$ 1 second repetition. This variation of the circuit is merely a two-interval repeating timer, but is better than that of either Fig. 4 or Fig. 9, as both intervals can be made long, over a minute, and are independently controllable.

Other methods exist for obtaining multiple interval timing with one tube and one relay. In general they are less flexible than using "n" timers in tamden, for "n" processes. However, their construction is simpler, and they are adequate for specific applications. All of the circuits described herein have the common advantage over mechanical timers of being readily adaptable to range changes by simply changing potentiometers. There is no need for gear removal or other mechanical adjustments.

Reference:
(1) P. T. Chin and E. E. Moyer, "A Graphical Analysis of the Voltage and Current Wave Forms of Controled Rectifier Circuits", Trans. AIEE, Vol. 63, pg. 501, 1944.

Television in 15 Cities

Latest grants of nine additional television licenses brings total of U.S. cities where television stations are either in operation or have been authorized to 15. Pittsburgh, Cleveland and Baltimore have sufficient number of channels available and hearings may not be necessary.

Among those newly licensed are: Raytheon Manufacturing Company, Waltham, Mass.; Worcester, Mass., Telegram; Outlet Co., Providence, R. I.; National Brooadcasting Co., Cleveland; KSTP, St. Paul, Minn.; Havens & Martin, Richmond, Va.; Intermountain Broadcasting Co., Portland; and A. S. Abell Co. (Baltimore Sun).

more efficient ...in miniature

ACTUAL SIZE

With the aid of a little hand microphone, the ship's officer, speaking in a normal voice, can be heard by any vessel in the fleet. Contrast this to the ineffectual bellowings through the huge megaphone of yesterday. The trend of science has been to develop greater efficiency in miniature. It was true of the megaphone, it is true of the electron tube.

TUNG-SOL Miniatures offer many advantages, especially in high-frequency currents. They are more impervious to shock and vibrations. The glass bases have better dielectric properties. They offer lower lead inductance, lower interelement capacitance and higher mutual inductance.

TUNG-SOL engineers will be glad to help you interpret your tube requirements in terms of Miniatures. TUNG-SOL is a tube manufacturer, not a set builder. The disclosures of your plans you make in consultation will be held in strictest confidence.

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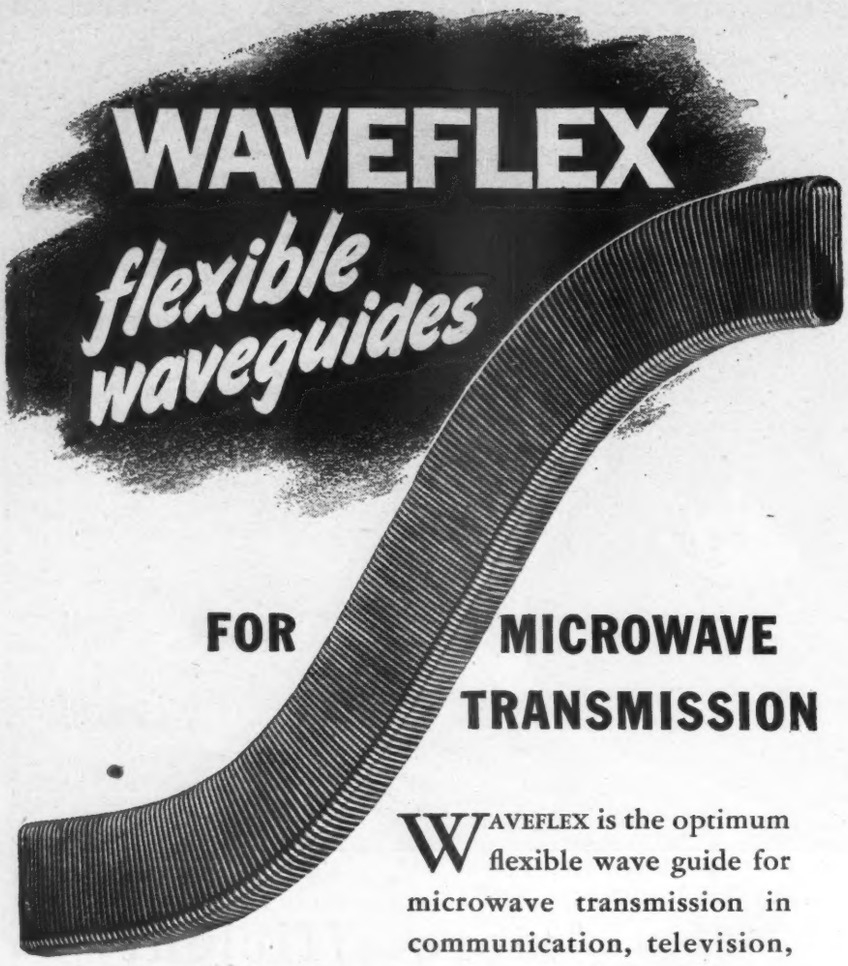


FOR MICROWAVE TRANSMISSION

WAVEFLEX is the optimum flexible wave guide for microwave transmission in communication, television, and radar applications on vessels, vehicles, and aircraft. It is particularly adaptable in installations where vibration, shock mounting, or movement are present.

The extreme flexibility of Waveflex permits confinement in "tight" corners without distortion of critical dimensions of size and shape. Small radii bends are possible with practically no change in electrical properties, thus overcoming the loss of energy due to reflection in microwave transmission. Precision construction with silver-plated inner surfaces further reduce attenuation and preserves costly transmission energy.

A new bulletin with specifications is available upon request. Write to: Titeflex, Inc., 539 Frelinghuysen Ave., Newark 5, New Jersey.

Titeflex

WAVEFLEX — THE FLEXIBLE WAVE GUIDE WITH COMPLETE ELECTRICAL CONTINUITY

HUMIDITY RECORDING

(*Continued from page 71*)

vapor pd is equal to its saturation pressure (ps_2). At this temperature (pd), partial pressure of the water vapor of $T°_{abs.}$ at $\phi\%$ humidity also follows the function of its upper limiting curve, when the dew point $T°_t$ is substituted as the temperature for T_s.

The following transformations may thus be obtained:

$$\text{Log ps} = A - \frac{B}{Ts}$$

$$A = 5.9778$$

$$B = 2224.4$$

$$\text{Log } ps_1 = 5.9778 - \frac{2224.4}{T°_{abs.}} \qquad (6)$$

$$\text{Log } ps_2 = 5.9778 - \frac{2224.4}{T°_{t\ abs.}} \qquad (7)$$

Equations (6) and (7) are true for the other temperature ranges, with values of A and B substituted as indicated in equations (4) and (5).

$$\phi\% = \frac{ps_1}{ps_2} \times 100 \text{ and}$$

$$\log ps = A - \frac{B}{T°_t}$$

$$\log \phi = \log \frac{ps_1}{ps_2} \text{ or}$$

$$\log \phi = \log ps_1 - \log ps_2$$

$$\log \phi = A - \frac{B}{T°_{abs.}} - A + \frac{B}{T°_{t\ abs.}}$$

$$\log \phi = B\left(\frac{1}{T°_{t\ abs.}} - \frac{1}{T°_{t\ abs.}}\right)$$

$$\log \phi = 100\ n \log B\left(\frac{1}{T°_{t\ abs.}} - \frac{1}{T°_{t\ abs.}}\right)$$

The relationship may be expressed by two artificial formulas Z_1 and Z_2 and may be represented electrically by a double bridge, from 20° to 100°C:

$$\log \phi\% = 100\ n \log \left(B\frac{1}{T°_{t\ abs.}} - B\frac{1}{T°_{abs.}}\right)$$

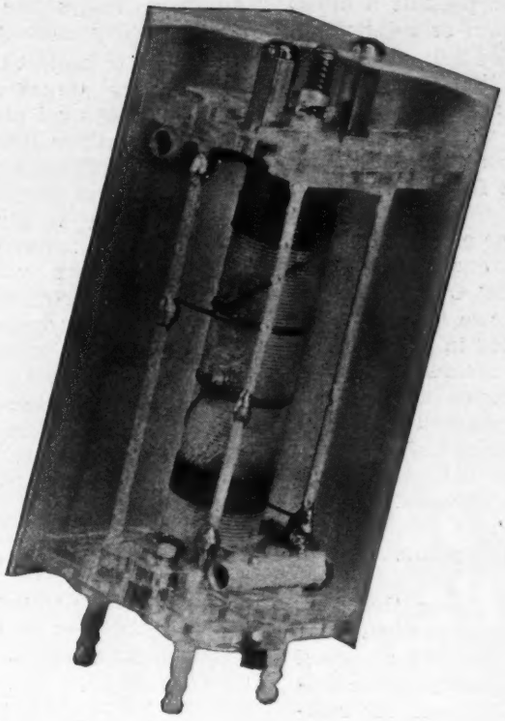
$$Z_1 = B\frac{1}{T°_{t\ abs.}} = 2224.4 \times \frac{1}{T°_{t\ abs.}} = 22.224 \times \frac{100}{T°_{t\ abs.}}$$

$$Z_2 = B\frac{1}{T°_{abs.}} = 2224.4 \times \frac{1}{T°_{abs.}} = 22.224 \times \frac{100}{T°_{abs.}}$$

The value of the relative humidity may therefore be represented in the following form:

$$\log \phi\% = 100\ n \log (Z_1 - Z_2)$$

wherein the difference $Z_1 - Z_2$ as an ohmic value may be read off by



NEW IF TRANSFORMERS

These new IF transformers are designed to meet the highest standards of performance in high frequency FM and AM. All operate at 10.7 MC., making them ideal for the new FM band. Iron core tuning is employed and the tuning does not affect the bandwidth of 100 Kc. for the IFN or 150 Kc. for the IFM.

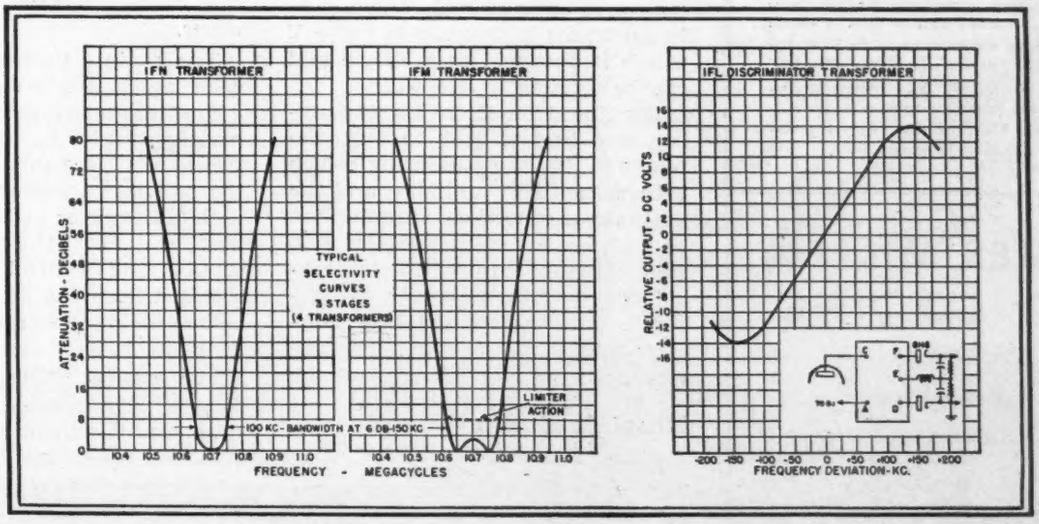
The discriminator output is linear over the full 150 Kc. output and remains symmetrical regardless of the position of the tuning cores.

Insulation is polystyrene for low losses. Mechanical construction is simple, compact and rugged. The transformer is 1 7/8 inches square and stands 3 1/8 inches above the chassis.

ARMY E NAVY

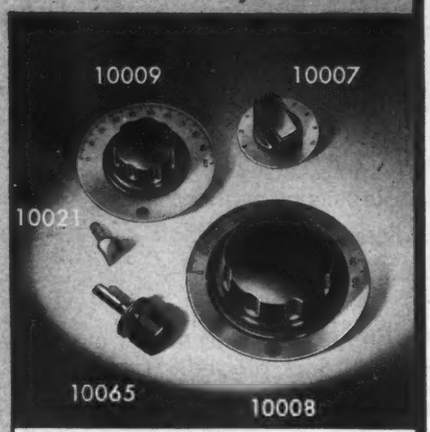
NC

NATIONAL COMPANY, INC., MALDEN, MASS.



Designed for

Application



The Millen Group of Plain Dials

The No. 10007, 8, and 9 group of nickel silver plain dials with specially designed matching knobs have accurately reamed brass bushings so as to insure concentricity. The dials themselves are insulated from the hubs by means of spacer ring molded as part of the knob. The small 10007 unit is available with either 180° standard scale or 280° for potentiometer use. No. 10065 is vernier drive device for use with No. 10008, 3½" dial. The knobs are also available less dials, for other uses.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

means of a resistance measurement.

The resistance scale is calibrated according to the value of the numerical logarithm of this ohmic value, and makes possible a direct or linear indication or registration $\phi\%$.

It is advisable that for an industrial measuring device which must always operate within a definite established temperature range, the constants A and B, be adapted to this range.

A universal type of apparatus for all temperature changes between —10° C and +350° C has fixed resistances, which are the constants A and B associated in pairs. Selection is made by means of a range switch. The sequence of measuring points may be regulated as desired by suitable adjustment of the water valve. The pointer deflection of the instrument is continuous, so that the humidity is also recorded between the individual points of measurement.

Experience has shown that best performance is obtained when using inked recorders. Except for a small grid battery, the photoelectric humidity meter is designed for ordinary line connection.

When the apparatus is used in rooms where the temperature is close under or above that of the tap water, cooling is provided. In rooms without a cooling equipment, other cooled water from the tap or tank is used.

The apparatus is suitable for remote reading if the resistances of the leads from the device to the indicating means are compensated. L, Z, R, W_2 are mounted on a common frame and their parts protected against all fumes and temperatures up to 350° C. The installation frame is fastened to valve V which is designed as a flange and can be screwed to the wall.

The thyratron St, the accompanying grid bridge, grid battery, the relays T_1, T_2, the measuring bridge with motors MF_1 and MF_2, and the network connection circuit are housed in a small auxiliary box, which is mounted near the indicating device G in back of a switchboard. The motors are two hummers with ratchet drives. The device operates without supervision.

Russia's Radio Plans

Russia plans to build three million radio broadcast receivers under the terms of its newest five year plan. It is also proposed to build new broadcasting stations in seven or more cities.

TWIN TRANSMITTERS

(*Continued from page 74*)

voltage to the modulator tubes. Auxiliary relays are required to control heavy contactors.

In order to protect the equipment from heavy surges or overloads, overload relays are placed in power tube and rectifier circuits. To protect the operating personnel, doors are interlocked with switches that interrupt the supply from high voltage circuits. Relays are used to ground all high voltage circuits when power is removed or when a door interlock is opened. The control circuits use switches, contactors, overload relays and time delay relays in starting the equipment in the proper sequence. The transmitter is designed to be started or stopped from the front panel or control desk.

Installation and tune up

In planning a transmitter installation of this size for the operating frequencies specified, considerable thought had to be given to the ground system within the building itself. To prevent induction currents, great care had to be taken to see that during building construction all metal parts of the building such as pipes, conduits, metal ducts, concrete reinforcement and metal flashings were adequately grounded. All metal parts were welded or soldered to a copper ground strap every ten feet and the entire mesh brought out to a common ground point for the entire system. All control rooms and studios were constructed with double-shield screens made of copper, one insulated screen within the other.

The radio frequency sections of each transmitter were installed on a continuous copper sheet, approximately 12 x 10 ft. square. These two sheets were in turn bonded to the two metal center partitions of each transmitter in such a manner that in effect the audio, power supply and control system was shielded from the heavy radio frequency fields, generated by the 50 kw rf sections.

The design of the transmitter dictated the use of water-cooled tubes and the cooling requirements of these tubes are such that an elaborate water cooling and circulation system had to be installed.

In view of the fact that a dual transmitter installation was planned, advantage of this fact was

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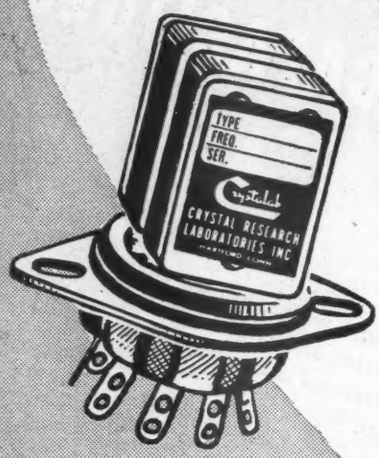

2,000KC—15,000KC Crystal mounted in Crystalab CRL-16 holder . . . STABLE—BX rated (— 30° C to +60° C at ±.01% frequency deviation) . . . LIGHT WEIGHT—17.5 grams . . . COMPACT—overall height 1.59", width .812", depth .438", holder height 1.125" . . . pin spacing .486" on centers . . . TWO CRL-16 holders fit a standard octal socket. Low temperature coefficient cut crystal clamped in a humidity sealed holder by heavy spring action. Especially adaptable to Aircraft, Marine, and Mobile units.

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taken in planning the water cooling system. Provision, in the way of suitable cut-off valves and by-pass lines, was made so that one of the four pumps (there are dual pumps for each transmitter) could be cut into service for either transmitter.

The installed capacity of each pump is such that it can readily deliver a flow of ten to fifteen gallons of water per minute past the anode of each water-cooled tube. In addition to the two standard storage tanks, a third was installed so as to have on hand ample distilled water to meet all emergencies.

Distilled water must be used, as the impurities in the average tap water would present a low resistance path to ground and offer potentialities for electrolytic action. The water-cooling system as installed is capable of handling 4.5 kw of filament dissipation and 25 kw plate dissipation or a total of 29.5 kw. The circulation system is of the closed type, the water being cooled in a heat transfer unit.

Performance measurements

Performance measurements at a power of 50 kw and over the frequency range of 6 to 22 mc presented some problems not altogether unique but considerably more difficult than those encountered in the standard broadcast band.

The specification states that the transmitter must deliver 50 kw of power into a resistive load of 300 to 600 ohms. Thus, the resistor, in which the power delivered is to be dissipated, must be capable of adjustment over the above range of resistance in such a manner that its input terminals present at all frequencies a pure resistance. Because of the power dissipation, the dummy load is of necessity water-cooled. The electrical network of this unit resolves into a simple balanced T network.

Satisfactory adjustment of the various elements for the desired resistive load could not be realized using the standard radio frequency bridge because of the physical size of the dummy load. Standard transmission line practice was used; that is, for various adjustments of the elements in the network, the standing wave ratio on a transmission line at least ½ wavelength long at the operating frequency was measured. The transmission line spacing was selected so that its characteristic im-

pedance represented the resistance to which the dummy load was to be adjusted. The elements in the load were varied until the standing wave ratio approached one to one. This method of adjustment was found to be relatively simple, accurate and fast.

It was found that a flow of 17 gal. per minute and a temperature rise of 11.2° C. between the inlet and outlet of the water to the resistor represented a power dissipation of 50 kw in the dummy load.

Distortion and frequency response measurements were complicated only because of the stray radio frequency voltages that persisted in appearing in the test equipment. It was found necessary to prepare a simple diode detector or rectifier and radio frequency pick-up coil which was placed adjacent to the output tank circuit of the transmitter. The voltage from the rectifier then was fed to measurement equipment through a pair of shielded conductors.

At the measurement equipment end a suitable filter was constructed for each side of this line as it was found there was still some radio frequency pick-up on the line itself. The measurement or test equipment was located approximately 25 ft. from the transmitter and considerable care had to be used in the selection of test equipment grounds. Best results were realized when only one common ground point was used and that at the test equipment end. The shielded conductors from the rectifier had to be insulated from ground to meet this requirement.

Typical field performance measurements were: Frequency response, ±1.3 db from 30 to 10,000 cycles; distortion at 100, 1,000 and 5,000 cps, 3, 1.5 and 3% respectively when measured at 90% modulation; noise levels, below 100% modulation at 1,000 cycles varied between —55 and —60 db; carrier shift less than 6% at 100% sustained modulation.

ELECTRONICS IN OIL

(*Continued from page 59*)

is exposed to the large surfaces of iron of the cracking unit. Some iron, either through corrosion or erosion, finds its way on to the catalyst surface. Through spectrographic analysis the amount of iron deposited on the catalyst surface can be studied. From the information on iron deposition combined with changes in catalyst activity

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TYPE 720
PANEL MOUNTING
DRY AIR PUMP

Specially designed for use in equipment requiring a small, built-in source of dry air. Only 2 inches in diameter, 6 inches long. Pressures as high as 30 pounds are easily generated. Piston type compressor drives air through a chemical drier. Pump supplies dry air with only 7 to 10% relative humidity. Additional silica gel refills available at reasonable cost.

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Designed over the simple tire pump principle, this all-purpose dry air pump has numerous applications. Output of each stroke is about 26 cubic inches of free air. Transparent lucite barrel holds silica gel. Supplied complete with 7-foot length of hose. Height 25½ inches. Net weight 8½ pounds.

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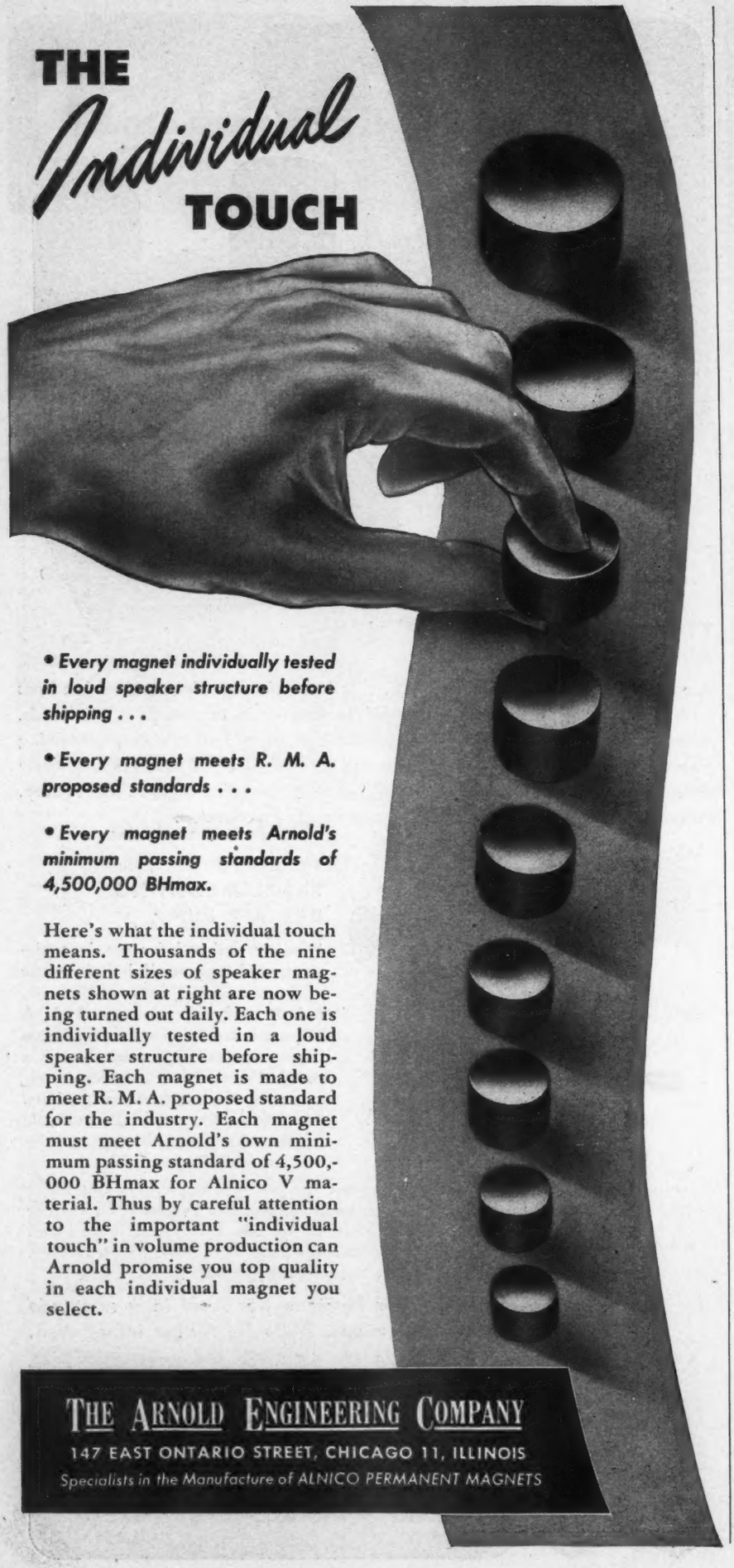

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• *Every magnet meets Arnold's minimum passing standards of 4,500,000 BHmax.*

Here's what the individual touch means. Thousands of the nine different sizes of speaker magnets shown at right are now being turned out daily. Each one is individually tested in a loud speaker structure before shipping. Each magnet is made to meet R. M. A. proposed standard for the industry. Each magnet must meet Arnold's own minimum passing standard of 4,500,000 BHmax for Alnico V material. Thus by careful attention to the important "individual touch" in volume production can Arnold promise you top quality in each individual magnet you select.

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the seriousness of contamination can be evaluated and the extent of effort required to overcome it determined.

Ultraviolet analyses found most use in the petroleum industry during the war in aviation gasoline and synthetic rubber developments. The analysis will continue to be useful for the peacetime adaptations of the synthetic processes employed. A wide variety of aromatic compounds are produced in aviation gasoline production and other refining operations. In order to identify the compounds, ultraviolet spectroscopy has been extremely useful.

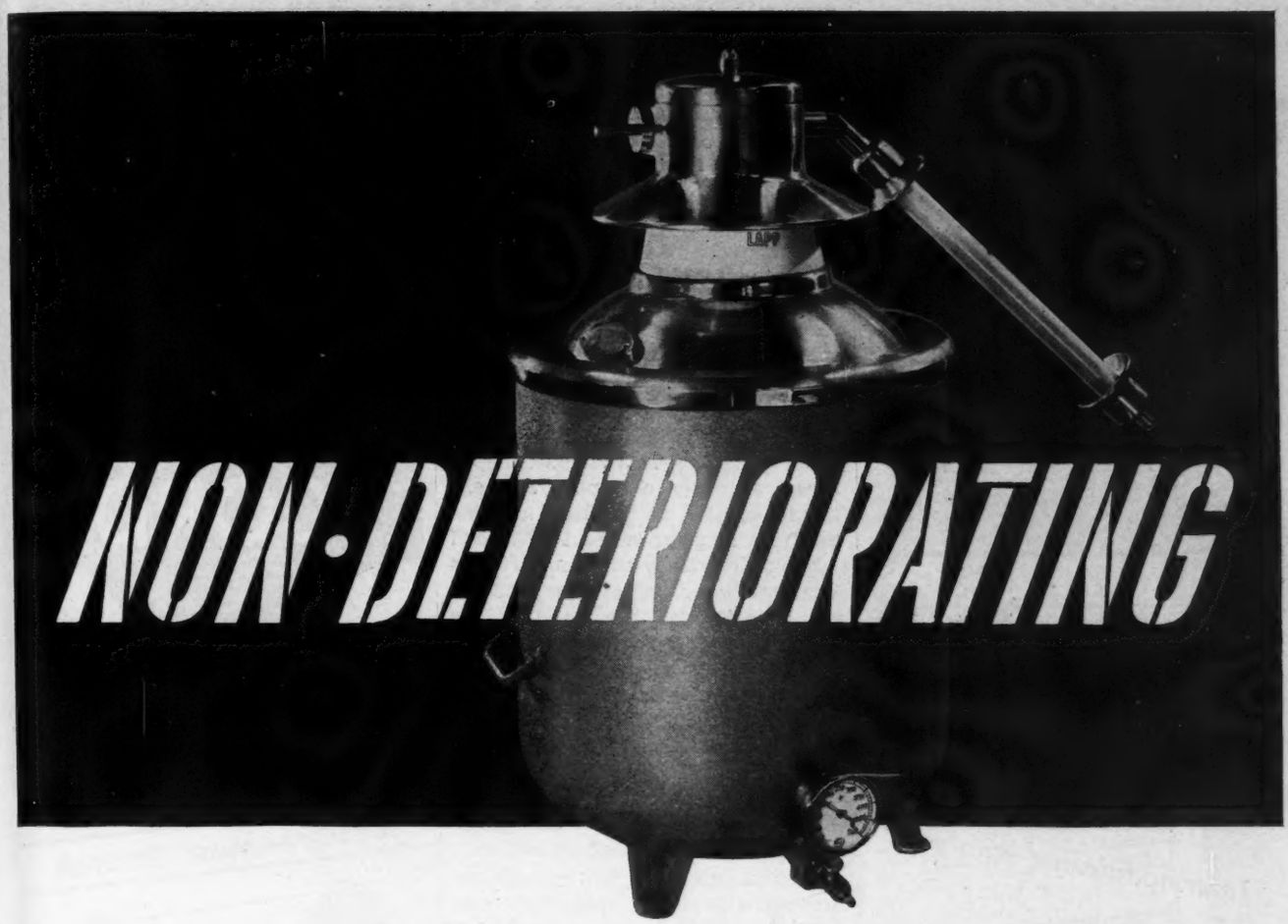
Ultraviolet spectrophotometer

Time savings through ultraviolet analysis like those for infra-red are very large. Analyses for benzene and toluene would require about four hours by other methods, whereas the ultraviolet method will take about ¾ of an hour. A mixture of xylenes might require 50 hours for chemical analysis, while it can be analyzed in about an hour by ultraviolet spectroscopy.

X-ray diffraction and Raman spectra are other devices indirectly or directly electronic that are finding a place in petroleum technology. X-ray diffraction is particularly useful in catalyst studies. Through the method compositions of catalysts can be determined and measurements made of crystal size. In view of the effect of both composition and structure on catalyst activity X-ray diffraction studies are extremely helpful.

The Raman spectrum is relatively a newcomer in the petroleum field. Utilizing monochromatic violet light, it depends for its effectiveness upon partial selective absorption of light energy by different molecules, resulting in a scattered light differing in wavelengths from the incident light. The scattered light resolved into its spectrum in a prism spectrograph and falling on a photo cell is very feeble. Electronic means are used to amplify the photocell currents to make them become measurable. The probable principal use of the Raman method in petroleum work will be for determining hydrocarbons present in mixtures such as gasoline.

Electronic devices of various sorts are used in petroleum analytical laboratories. Electrometric titrations are often necessary where color, emulsification or other factor make the use of conventional chemical indicators impossible.



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TELE INTERFERENCE

(*Continued from page* 61)

allocations. On the other hand, on line 8, the scientific, industrial and medical services have been allocated a channel just about 27 mc. If these services produce high powered signals and wander substantially out of the assigned channel, they will cause serious interference directly through the television receiver at intermediate frequency.

Local oscillator radiation of a television receiver tuned to one channel may cause interference to other receivers in a neighborhood tuned to other channels. For example, on line 24 the local oscillator for a receiver tuned to Channel 4 has a frequency of 80 mc. If this local oscillator radiates a substantial signal from the antenna, its signal may be picked up on a nearby receiver tuned to Channel 5 as indicated on line 25. This local oscillator at 80 mc will beat with the desired picture carrier for Channel 5 at 77.25 mc to produce a video frequency of 3.75 mc which will appear as a fine grained interference on the television picture.

This interference will remain of substantially fixed frequency but may cause vertical or diagonal weaving lines due to the slight drift in frequency between the transmitter carrier and the interfering local oscillator. Interference from a nearby local osillator can usually be distinguished from interference produced by an FM station in that the local oscillator interference pattern stays relatively stationary while the interference from the FM station continually changes with the extent of frequency modulation of the FM transmitter.

FM For St. Louis

St. Louis shortly will have in operation its first FM broadcast station. The transmitter will be a 50 kw unit and is to be installed by Station KWK. Both the transmitter and the eight bay square loop antenna are products of the Federal Telephone & Radio Corp. Federal also will install two 50 kw standard AM broadcast transmitters in the near future for the Canadian Broadcasting Corp. One will be operated from Winnipeg, Manitoba and the other from Edmonton, Alberta.

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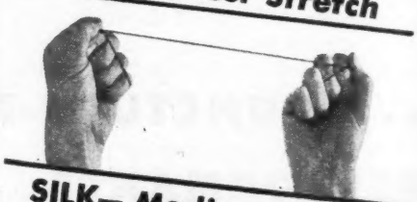

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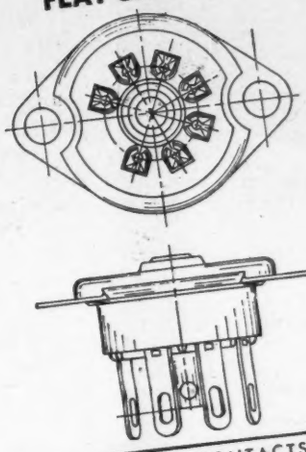
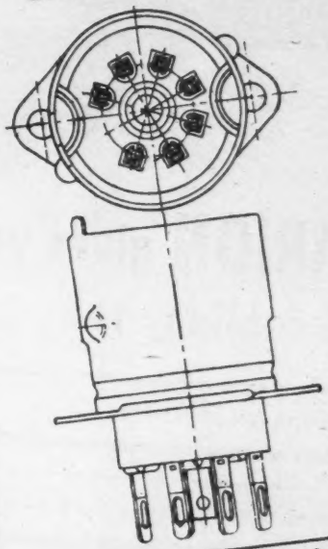


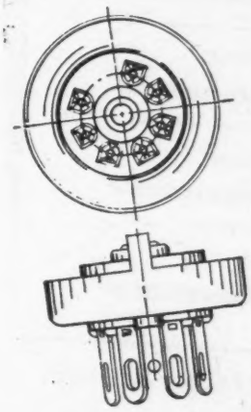
INSULATOR PART NO.	CONTACTS	
	Phos. Bronze	Beryl. Copper
General Purpose	8323	8100
Ceramic	8326	8083
Mica-filled Phenolic	8327	8082

SHOCK SHIELD

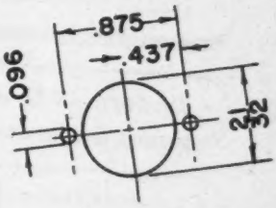


INSULATOR PART NO.	CONTACTS	
	Phos. Bronze	Beryl. Copper
General Purpose	8322	
Ceramic	8328	7676
Mica-filled Phenolic	8329	7670

NON-MICROPHONIC



PART NO. 8341



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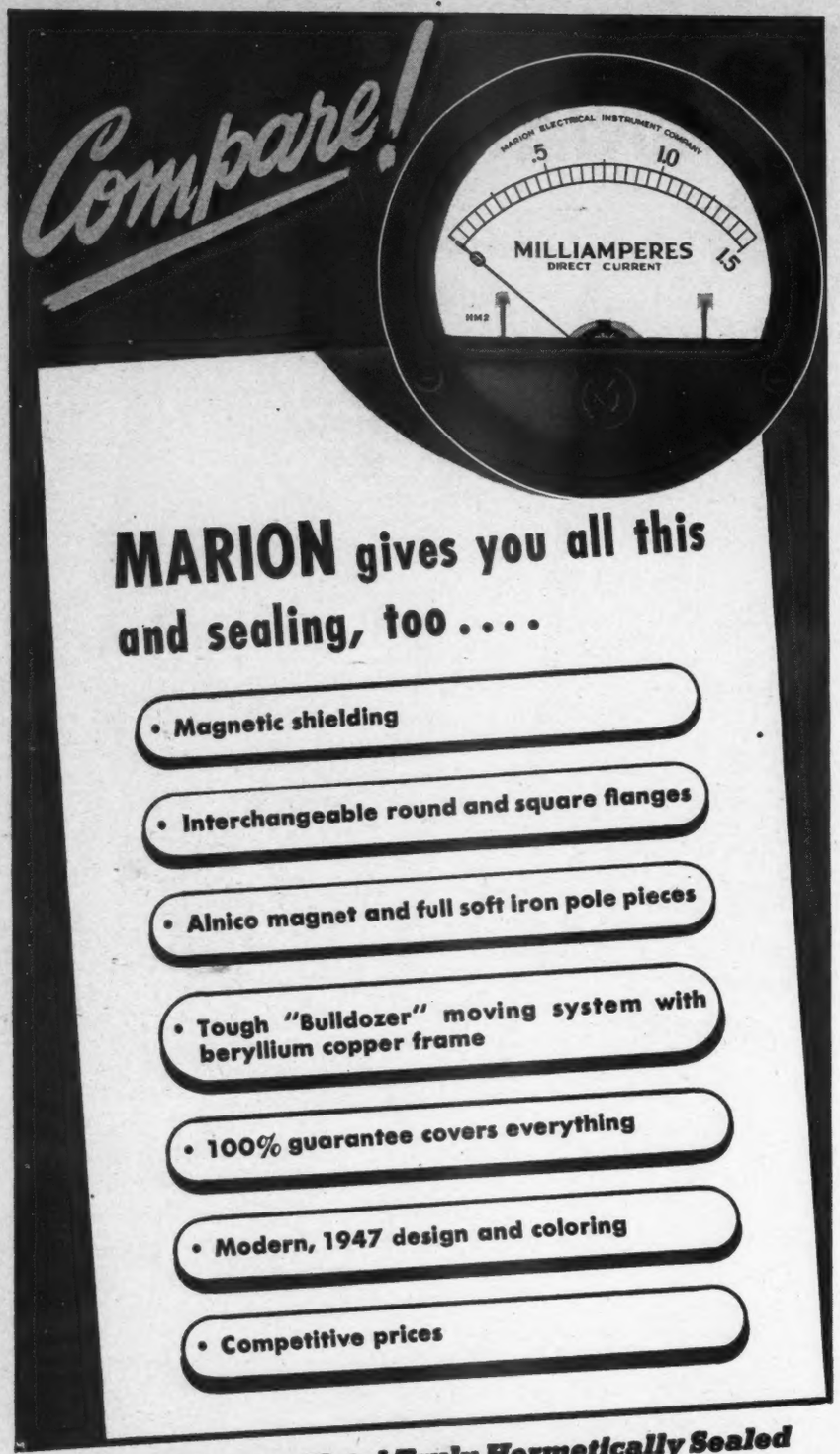
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By V. K. Zworykin, E.E., Ph.D.; G. A. Morton, Ph.D.; E. G. Ramberg, Ph.D.; J. Hillier, Ph.D., and A. W. Vance, E.E., all RCA Laboratories, Princeton, N. J.; published by John Wiley & Sons, Inc., New York City, and Chapman & Hall, Ltd., London; 1945; 766 pages; $10.

Written by the foremost authorities on electron microscopes who are responsible for recent developments in this branch of electronics, this comprehensive text may be expected to become a standard reference book for the electron optical engineer as well as for the electron microscopist. With these two distinct aspects in mind, the authors have divided the subject matter into "Part I—Practical electron optics and electron microscopy" and "Part II—Theoretical basis of electron optics and the electron microscope."

In the first section the basic principles, operating characteristics and possibilities of various types of electron microscopes available are set forth in non-mathematical terms, and practical information essential for effective operation of this instrument is given. The second section presents a survey of theoretical electron optics and is intended to assist in the design of electron optical instruments. Behavior of electrons in magnetic and electric fields are studied; aberrations of electron lenses are treated and relativistic corrections are considered.

Quartz Crystals

By R. A. Heising, Technical Staff of Bell Telephone Laboratories. Published by D. Van Nostrand Co., 250 Fourth Avenue, New York. 563 pages, illustrated and indexed. Price $6.50.

If one were to judge by the immense amount of information contained in this studious examination into the subject, there remains little to be discovered, or said about, the development and manufacture of quartz plates for electrical subjects. The text is complete to the point of being exhaustive. The seventeen chapters represent the assembled work of scientists and engineers of the Bell Telephone Laboratories who have studied crystals and their adaption to telephone and radio circuits almost ever since Pierre and Jacques Curie discovered the piezoelectric prop-

research

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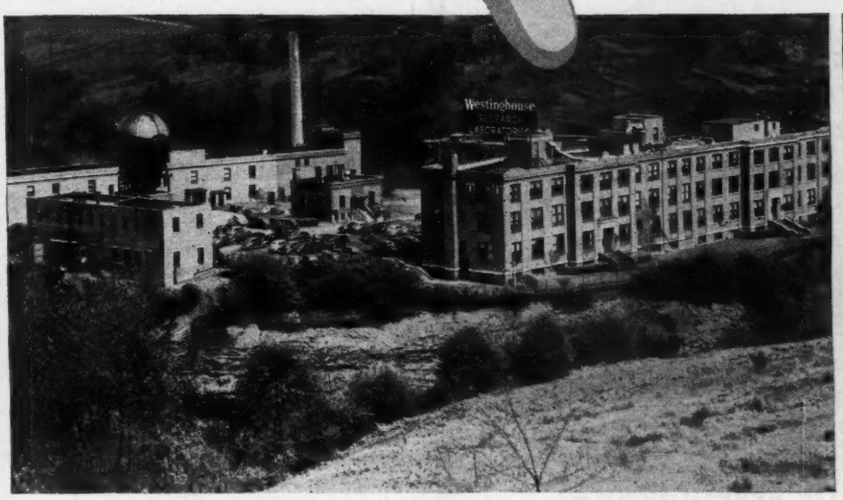

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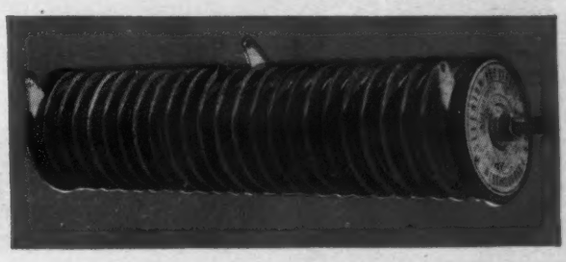


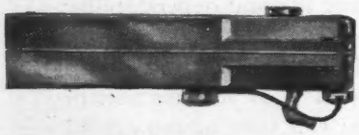
Astatic goes Nylon

Designs NEW Pickup Cartridge with NYLON Chuck and REPLACEABLE, Long-Life, Sapphire-Tipped NYLON Needle

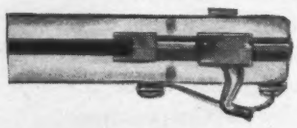
● Constantly alert to the possibilities for improvement in the design and performance of phonograph pickup cartridges, Astatic research has unearthed a material, other than metal, for the better transmission of signals from the record grooves to the crystal element. That material is NYLON! No other known substance possesses all the properties which make Nylon ideal for this purpose. Astatic, therefore, has employed this revolutionary material in the manufacture of a new crystal pickup cartridge known as Astatic Nylon 1-J . . . a low pressure, wide-range, general purpose cartridge incorporating a Nylon chuck and Nylon, sapphire-tipped needle.

CONTROL OF QUALITY OF REPRODUCTION

In using this Nylon 1-J Crystal Pickup Cartridge, the phonograph manufacturer, as well as the user, is assured that the quality of reproduction will REMAIN CONSTANT regardless of needle replacements, because the cartridge is matched to the needle, and the Nylon needle designed for this particular Cartridge is the ONLY one that can be used with it.



PARTIAL VIEW of cartridge, showing knee-action Nylon needle and metal needle guard. The cushioning action of Nylon affords additional protection for the sapphire stylus.



INTERIOR VIEW showing crystal element, Nylon chuck and sapphire-tipped Nylon needle.

PHANTOM VIEW showing how tapered shank of Nylon needle fits into tapered hole in Nylon chuck.

Astatic Crystal Devices manufactured under Brush Development Co. patents.

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erty of quartz in 1880. Heising, whose fame rests largely on his work with modulation technics, wrote only the introduction, which is a historical exposition of the discovery and consequent development of quartz plate properties. The book is practical to the extent that mathematical analysis is widely relied upon to make plain an understanding of what goes on when crystals are used in their various modes and for the many applications of various cuts currently in use. The volume is a valuable compendium of quartz crystal information.

Electron and Nuclear Counters

By Serge A. Korff, M.A., Ph.D., Associate Professor of Physics and Supervisor of Physics Research, College of Engineering, New York University. Published by D. Van Nostrand Co., Inc., 250 4th Ave., New York. 212 pages, $3.

This is an extensive and scholarly summation of the pertinent facts regarding the theory of discharge mechanisms and the practical operation of various types of ionization counters. Methods of counting various forms of atomic particles are fully described and the influence of construction of the ionization chambers is discussed in detail. Other sections of the book are devoted to the methods of preparation and construction of counters and to errors and corrections involved. The last part of the book is devoted to a discussion of the auxiliary electronic circuits needed to operate counters.

The text is readable and clear in exposition. It seems an excellent source book for workers in this field.

Airadio Adds Capacitors

Production of variable capacitors has been added to the products manufactured by Airadio, Inc., Stamford, Conn. Both 2 and 3-gang RMA class B type will be produced, the former with four trimmers and the latter with a maximum of six trimmers.

Paragon Moves

Paragon Electric Co., has consolidated all main office activities at Two Rivers, Wis. Coincident with the move from Chicago, E. V. Platt, for many years executive vice-president, has been elected president. Increase in manufacturing facilities will triple the output.

PRODUCTS THAT SHOULD BE ADVERTISED IN THE *September* ISSUE

A partial list representing 10% of the products that can be logically promoted in this issue.

Aircraft landing control
Aircraft receivers
Alarms
Altimeters (electronic)
Ammeters & milliammeters
Amplifiers
Analyzers, color, gas, surface
Analyzers, internal combustion
Analyzers, pulse
Analyzers, radio set
Anoxia photometers
Antenna
Attenuation meters
Attenuators
Audiometers
Automatic alarm receivers
Aviation (xmitters)
Balances, electronic
Blower units
Bombarders, V. T.
Bridges
Broadcast monitor equip.
Broadcast studio equip.
Broadcast (xmitters)
Cable
Calibrators
Calibrators, pulse
Capacitance standards
Capacitor checkers
Capacitors
Cardiograph, electronic
Carrier current systems
Cathode ray oscillographs
Cathode ray tubes
Circuit breakers
Coils, special
Combustion controls
Conductivity controls
Counters
Crystal calibrators
Crystal ovens, temp. controlled
Crystals
Decade boxes
Decibel meters
Densitometers, photo-elect.
Detectors, lie
Diathermy
Dielectric heating
Dimension controls
Dimension gauges, electric
Direction findings
Directional antennas
Distortion meters
Door controls
Drying, infra-red equipment
Electric furnaces
Electric micrometer
Electric motors
Electrodes, welding
Electro-encephalograph
Electronic viscosimeters
Electronic voltmeters
Electron microscopes
Exposure meters
Facsimile
Field strength meters
Film recorders
Filters, power supply
Filters, R. F. noise
Flaw detectors, metal
Flow controls
Frequency changers, vibrators
Frequency deviation monitors
Frequency measuring devices
Frequency monitors
Frequency spectrum analyzers
Frequency standards
Galvanometers
Gages
Generator controls
Generators, AC electric
Generators, high frequency
Generators, video pattern
Geophysical instruments
Germicidal lamps
Grading & sorting controls
Graphic recorders
Harmonic analyzers
Harmonic generators
Heat treating controls
Heating, dielectric induction
Humidity controls
Hygrometers, electronic
Indicators
Inductance standards
Instrument parts
Insulation
Insulation testers
Insulators
Interference analyzers
Ionization gauges
Klystron tubes
LC meters
Lenses
Lever controls
Light intensity meters
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Megohm meters
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Multi-meters
Needles
Neon test lights
Noise meters
Noise locators
Ohmmeters
Optical equipment
Oscillators
Oscillographs, direct-writing
Oscilloscopes
Output meters
Package wrapping controls
PH meters
Phase angle meters
Photo-electric controls
Photometers
Plan-position indicators
Police receivers
Police (xmitters)
Potentiometers
Power supplies
Pressure controls
Printing controls
Proximity indicators
Pulse generators
Pumps, vacuum
Pyrometers
Q meter
Racks
Radar
Radio set analyzers
Radiotelatype transmitter
Rectifiers
Relays
Remote control motors
Repeaters, radar
Resistance standards
Resistors
R. F. chokes
R. F. coils
Rheostats, power
Rotary beam
Rotary selector switches
Safety control, machine
Selsyns, etc.
Sensitized papers
Servo control systems
Signal generators
Signal tracers
Smoke density controls
Sorting controls,
Sound effect records
Speakers
Spectographic equipment
Spring testing equip.
Square wave gen.
Starters, motor
Stroboscopes
Switches
Tachometers
Television transmitters
Temperature controls
Temperature test cabinets
Thermistors
Thermocouples
Thermometers & pyrometers
Thermostatic metals
Time controls
Time delay relays
Timers
Traffic controls
Transformers
Transmitters
Tube testers
Tuning forks
Vac. tube voltmeters
Vacuum tubes
Vibration control equipment
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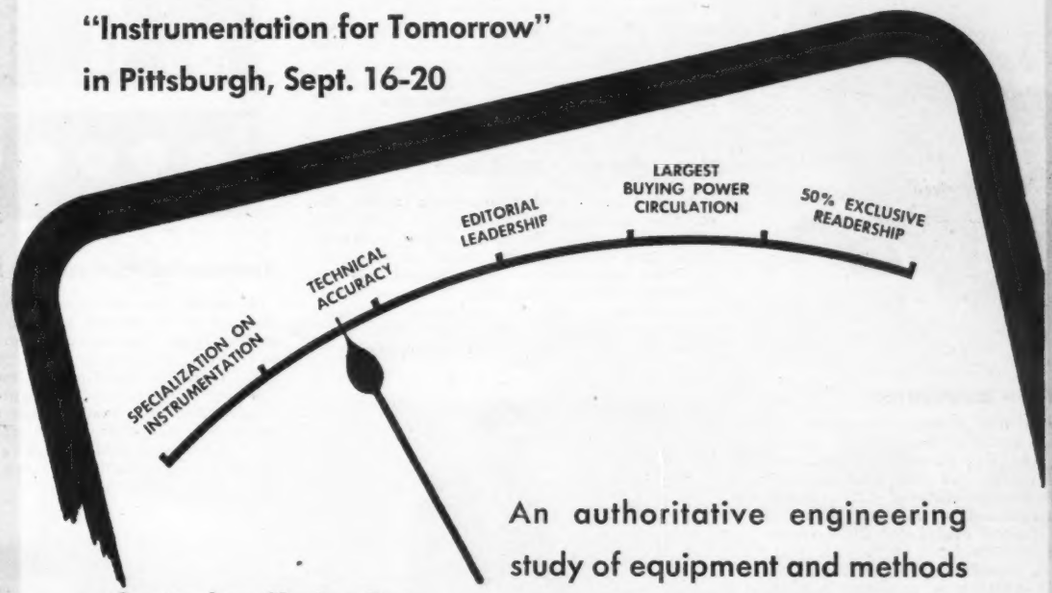

September Closing Date
August 1

Copies of the September issue will be distributed before and during the I.S.A. Exhibit.

Largest circulation in the three groups having the greatest buying power for electronic instrumentation—Manufacturers, Communications and Industrial Users. 18,293 total circulation.

An authoritative engineering study of equipment and methods used in a wide variety of electronic controls for industrial processing, communications and radio-electronic manufacturing . . . accenting a long series of instrument features published in ELECTRONIC INDUSTRIES in the past three years.

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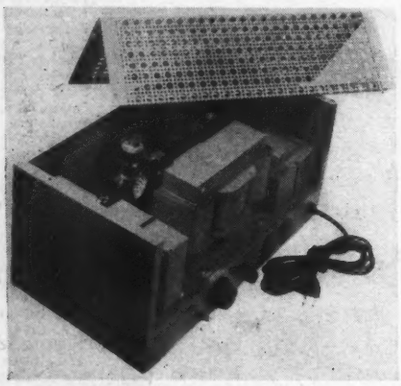
WHAT'S NEW

SEE ALSO PAGES 88-90-92-94

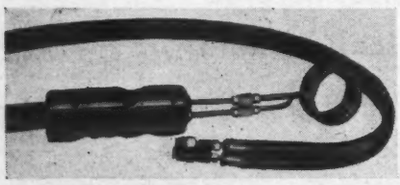
Gas Switching Tubes

Gas switching tubes for high speed automatic transmit-receive service in waveguides for radar and pulse time communication systems in the 8490-9600 mc. range have been developed by Sylvania Electric Products, 500 Fifth Ave., New York. In practice two tubes, a TR and an Anti-TR type are mounted in separate branches of the waveguide system.—Electronic Industries



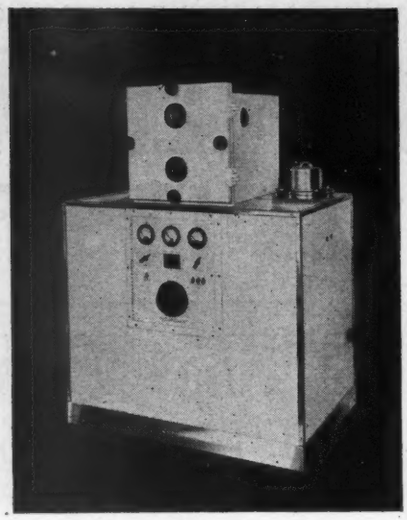
Line Voltage Regulator

A 400 cycle line voltage regulator for aircraft, weighing 12½ lbs. and developed by Sorenson and Co., Stamford, Conn., will supply loads up to 500 volt-amperes with voltage regulation accurate of 0.2%. Regulation is maintained within a frequency range of 360 to 500 cycles and for a variation of input voltage from 95 to 125. Output voltage is adjustable from 110 to 120. Fosterite impregnation is provided against humidity and corrosion.—Electronic Industries



Induction Heating

A flexible lead and coil set-up designed to provide induction heaters with a degree of flexibility approaching a soldering iron has been developed by Induction Heating Corp., 389 Lafayette St., New York. The heating coil is mounted on a grip-type handle and connected to a standard output transformer by the specially designed flexible leads.—Electronic Industries



Dehydration Unit

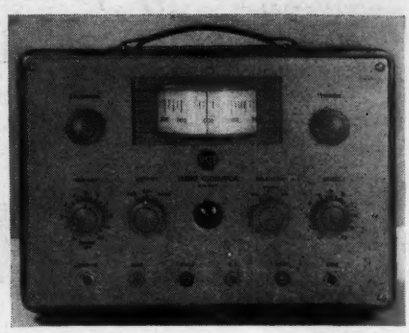
A small dehydration unit for use in laboratory or in pilot production has been developed by National Research Corp., Boston, Mass. The unit consists of a 2 in. coil diffusion pump in conjunction with 12.5 cfm mechanical pump, three thermocouple gages and a drying cabinet. It is designed for the desiccation or concentration of heat-sensitive biologicals, antiobiotics, food products and fine chemicals.—Electronic Industries

Transformer Bushings

Hermetically sealed bushings made of steatite glazed permanently to stainless steel, both multiple and single terminal styles are being manufactured at General Ceramics and Steatite Corp., Keasbey, N. J. Current carrying capacities for these units range from 1 amp. to 20 amps. Voltage flashovers ratings are from 2,000 volts rms to 40,000 volts rms.—Electronic Industries

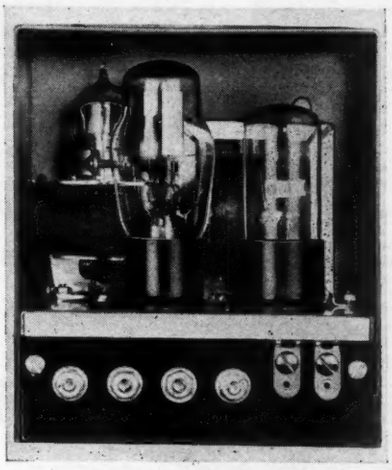
Coaxial Dipole

Serdex, Inc., 91 Cambridge St., Boston, Mass., has developed a coaxial dipole antenna designed for the 144-148 mc band. The antenna maintains high efficiency over the entire band. The model is 5 ft. high with a tubular mast that is both support and feed line.—Electronic Industries



Audio Oscillator

The new RCA type WA-54A beat frequency oscillator has a frequency range of 20 to 17,000 c/s and output of 125 milliwatts at impedances of 250, 500 or 5,000 ohms. A cathode-ray tuning eye with adjustable sensitivity monitors the output voltage and also serves as a line frequency zero beat indicator.—Electronic Industries



Industrial Electronic Switch

Hermetically sealed relay contacts permit the use of the Model 8336 electronic switch in industrial applications where explosion is a hazard. Manufactured by the Ripley Co., Inc., formerly the United Cinephone Corp., 65 New Litchfield St., Torrington, Conn., the Model 8336 can handle loads up to 30 amperes for floatless control of liquid levels and other applications where pressureless, instant acting limit switching is desired.—Electronic Industries

Aircraft Radio

The second in a line of aircraft communication equipment for private flying has been brought out by Maguire Industries, 1437 Railroad Ave., Bridgeport, Conn. The model ART-1 "Skyline" transmitter consists of an 8-watt, 3105 kc crystal controlled unit with a working range from 15 to 30 miles on a fixed antenna. During transmission the battery drain is 5 amps. Transmitter and power supply are contained in a single housing controlled by a remote control box.—Electronic Industries

The Record Changer That Gives You Everything!

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Sound on a wire as thin as a hair! The new Seeburg Wire Recorder permits perfect home recording of speeches, plays, music—it takes radio programs off the air. One simple control knob makes anyone a skilled sound technician. A new development everyone will want in tomorrow's phonograph.

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for radio manufacturers to make provision in their circuits to accommodate the Seeburg Wire Recorder. We invite inquiries from radio manufacturers.

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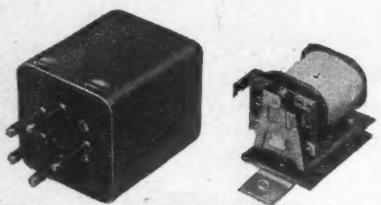

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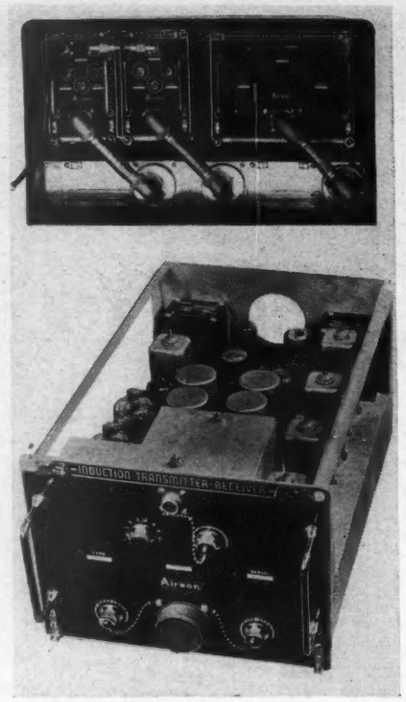
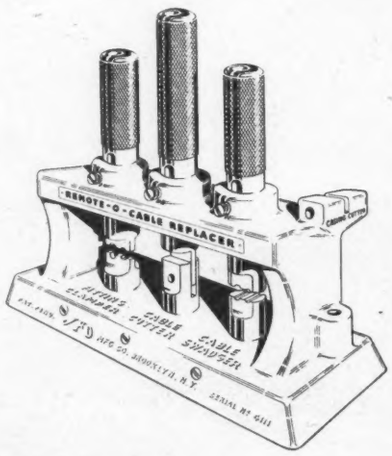


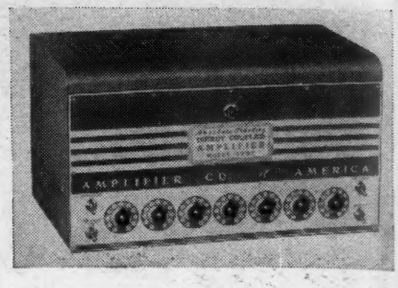
Railroad Radio Equipment

Aireon Mfg. Co., Kansas City, Kans. has developed two new railroad communication units. For caboose to station link model 520A mobile induction transmitter-receiver is used for "carrier" communication. A frequency modulated carrier of 50 watts output operating in the 70-200 kc band gives a mobile to fixed station range up to 50 miles. The equipment, which is pretuned and remotely operated has a separate power supply for 32 or 62 V dc and a power consumption of 100 watts on standby and 300 watts during transmission. For the head to rear train link and similar applications vhf equipment operating in the 152-162 mc band consists of a power supply, FM transmitter and receiver packaged for remote operation. A crystal oscillator followed by doubler and tripler stages and a power amplifier delivering 15 watts rf output make up the transmitter unit. Power consumption of the equipment is approx. 125 watts for standby and 250 watts during transmission periods.—Electronic Industries



Cable Replacer

Shafting may be swaged and cut to any desired length, old and new fitting can be replaced by means of the improved model of the Remote-O-Cable Replacer manufactured by J F D Mfg. Co., 4117 Fort Hamilton Parkway, Brooklyn, N. Y. The fitting of shafting to any dashboard head is facilitated with this tool.—Electronic Industries



DC Amplifier for 20-20,000 c/s

Model ACA-100DC audio amplifier developed by the Amplifier Co. of America, 398 Broadway, New York 13, has five push-pull direct coupled stages, with a total gain of 96 db, delivers 23 watts at 1% total harmonic distortion. The frequency range covers 20 to 20,000 c/s within ±1 db, or 15 to 28,000 c/s within ±3 db. Other features, such as 100 and 10,000 cycle equalizers, a low frequency attenuator for speech reproduction, a 10 db record scratch suppressor and a 10 db volume expander having adjustments for both expansion ratio and expansion time constant, provide great flexibility for studio and laboratory applications. The two input channels have fixed impedances of 500,000 ohms, while a tapped output transformer provides fifteen possible output impedance combinations from 1 to 500 ohms, either balanced or unbalanced to ground.—Electronic Industries

Strain Gage Indicator

Changes in length of specimens to one millionth of an inch per inch may be detected by use of the model RD strain gage indicator developed by Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, Calif. Specifically designed for measurement of strain in conjunction with standard resistance wire strain gages, the indicator provides two ranges: ± 1000 microin. per in. and ± 10,000 microin. per in. A gage factor control permits direct reading with gage factors between 1.7 and 2.1.—Electronic Industries

Fixed Frequency Receiver

A fixed-frequency AM receiver for the 300 to 400 mc range, that is crystal controlled and has an accuracy of 2 parts/million/°C, is in production at Lavoie Laboratories, Morganville, N. J. The receiver has a sensitivity of 3 microvolts for a 12 db signal to noise ratio and a bandwidth of 0.8 mc for 6 db down. Undesired responses are 70 db below carrier level. Output is 4 watts for 10% distortion from 100 to 3000 cps. Power consumption is 80 watts at 117 V, 60 cycle ac.—Electronic Industries

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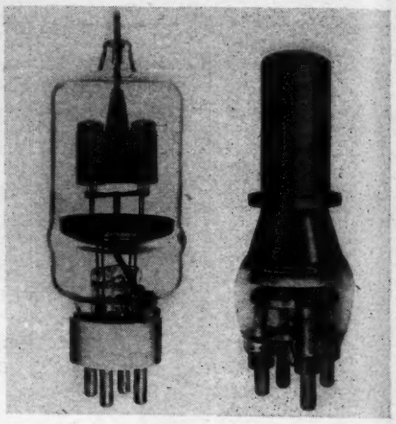
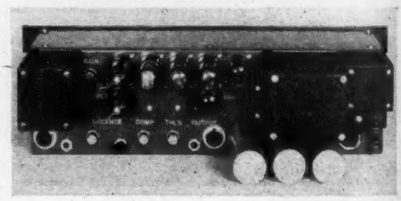
Multi-Element Triode

A multi-element triode suitable for television and industrial heating applications has been brought out by Eitel-McCullough, San Bruno, Cal. A new-type plate and non-emitting grid are characteristic for the tube, which is available in two types, either as high mu or low mu triode. In Class C amplifier or oscillator applications up to 600 watts plate power may be obtained.—Electronic Industries (Left, below)



Water-Cooled Triode

A new high power triode developed for use with frequencies up to 50 mc. in radio transmission and dielectric heating units is being made by Machlett Laboratories, Springfield, Conn. Tube construction features one piece anode and both the grid and the filament structures are mounted from single piece high conductivity copper supports assuring maximum strength and freedom from inter-electrode shorts. Kovar used for glass seals replaces conventional featheredged copper seals.—Electronic Industries (Right, above)



Regulated-Output Amplifier

The Series S139 regulated-output amplifier has been specially designed for use in airways and other voice communications circuits to provide automatic noise suppression and automatic rms level control. Basically, it is a high gain push-pull amplifier which holds the rms output level to within 1db. with input level variations as great as 40 db., and automatically reduces the gain by a factor of up to 22 db. during periods of circuit idleness. The frequency response is uniform to within 1 db. over a range of 100 to 4,000 cycles, and for a condition of 40 db. compression the distortion does not exceed 3%. The output level may be adjusted to regulate at any point within the range of —10 to +10 db. (6 mw. base) and the noise suppression circuits may be adjusted over a range of 0 to —22 db. Full automatic control is established within approximately two voice cycles at any frequency. Hum and noise level are over 45 db. down from zero level. This equipment is available for use as a 75 db. microphone amplifier or as a 50 db. line amplifier. Physically, it consists of a vertical panel and chassis combination with all components, controls and adjustments mounted on the rear of the chassis. Manufacturer is Schuttig & Co., Ninth and Kearny Streets, N. E., Washington 17, D. C. —Electronic Industries

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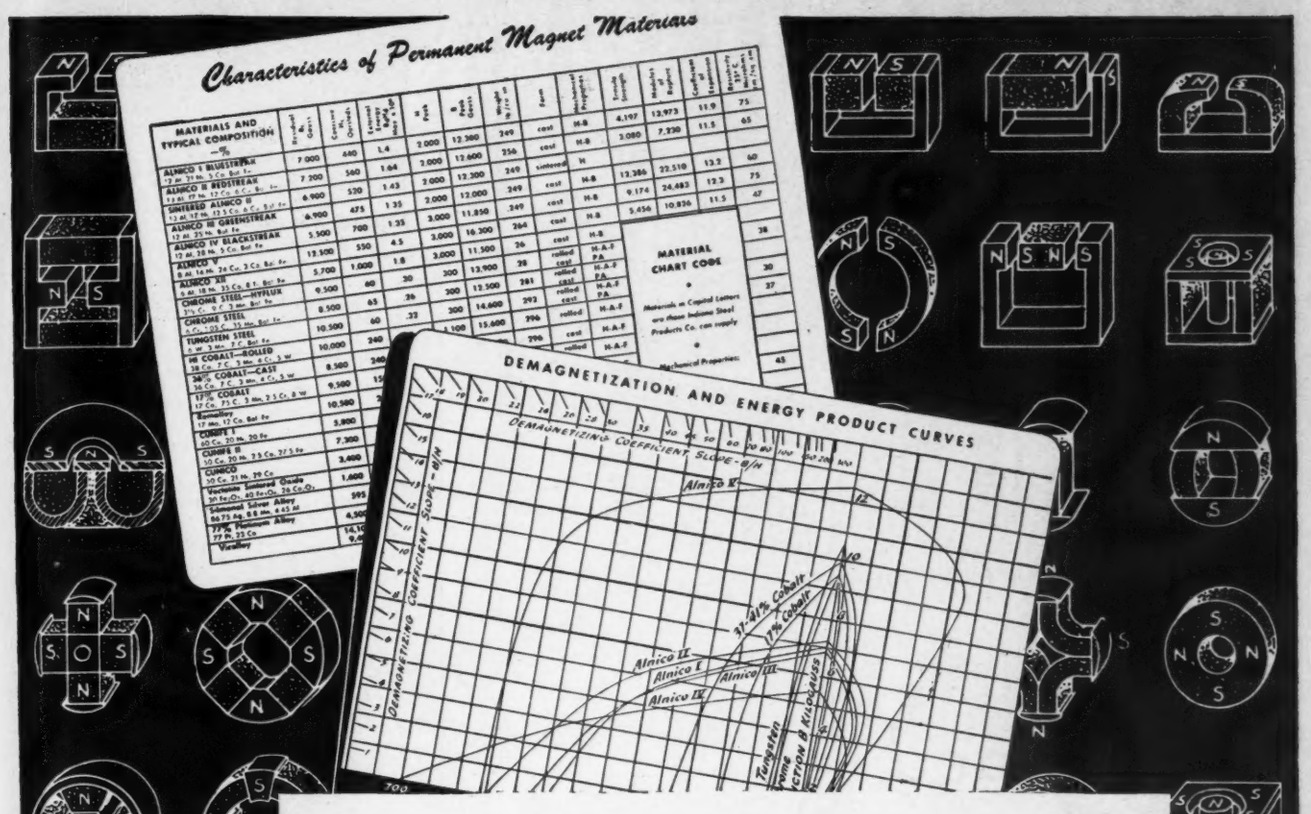

Helpful Reference Data for Use of "PACKAGED ENERGY"

Of special interest to engineers and product designers—here are two helpful reference charts, shown in reduced size above, on the *energy product* and *physical characteristics* of permanent magnets featured in the latest "Permanent Magnet Manual", prepared by *Indiana Steel Products Company.*

This manual contains valuable technical data on uses and applications of permanent magnets; modern materials and methods of fabrication—including complete information on the facilities of the Indiana Steel Products Co., the world's largest producer of "Packaged Energy". Ready for prompt mailing to any firm or individual considering commercial magnet application, this manual is available without cost.

More than 24,000 applications of "Packaged Energy" have been developed by our engineers. They are intimately acquainted with all grades of permanent magnet materials and problems of design and application. You are invited to consult with them without obligation.

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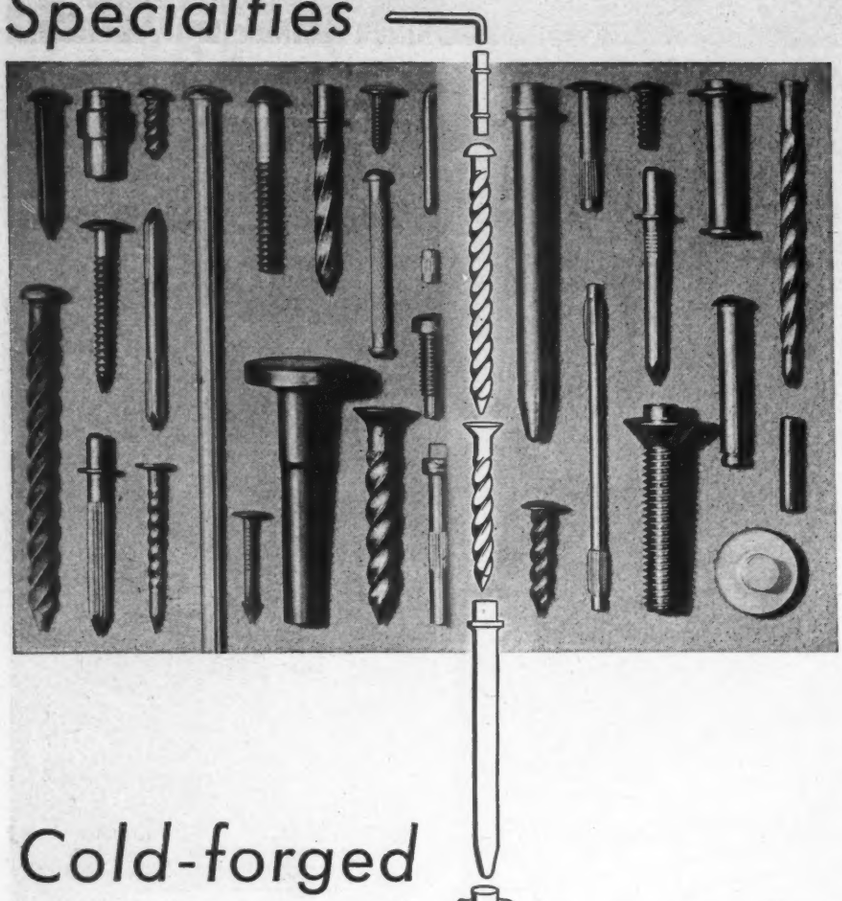

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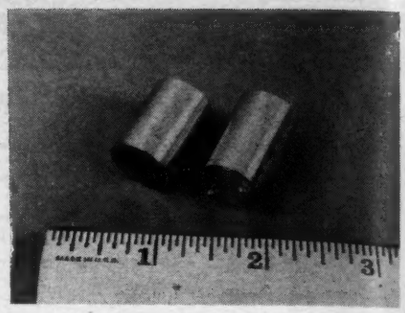
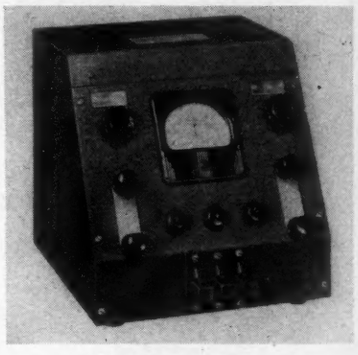


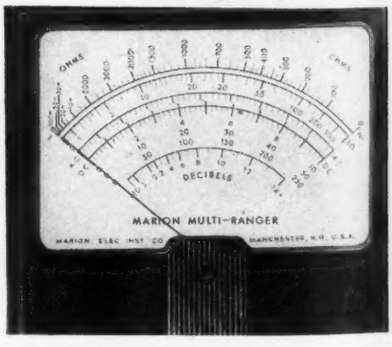
Sound Standard

For measurements requiring an acoustic, electric transducer of laboratory accuracy, the Model M-101 sound pressure measurement standard is available from Massa Laboratories, Inc., 3868 Carnegie Ave., Cleveland 15, Ohio. A nominal sensitivity of 23 microvolts/dyne/cm2 sound pressure, acoustic impedance greater than 0.001 cc of air, resonant frequency above 40 kc and electrical impedance throughout the audio range equivalent to a 100 mmf capacitor are characteristics. Applications include precise sound measurement in either free fields or small enclosures over a wide dynamic range, blast wave analysis from explosions or gunfire and use as a calibration standard for microphones, loud speakers and other acoustic devices.—Electronic Industries



Resistance Limit Bridge

The Model 81-A low range limits bridge developed by Associated Research, Inc., 231 S. Green St., Chicago 7, is a self-contained instrument for sorting any resistive components in the range from a fraction of an ohm to 20,000 ohms according to any desired tolerance from ±1% to ±20%.—Electronic Industries



Multi Range Instrument

A foundation instrument to be used as voltmeter, milliammeter, high and low resistance ohmmeter, ac voltmeter and decibel meter has been brought out by Marion Electrical Instrument Co., Manchester, N. H. The basic sensitivity of the instrument is 400 microamps, and it has an internal resistance of 500 ohms. Alnico Magnets are used.—Electronic Industries

You'll save time and money if a standard plug and jack, terminal, or connector will meet your requirements. Here at JOHNSON you'll find a complete line including practical and economical "Banana Spring", and "Spring Sleeve" type plugs and jacks. These are outstanding connectors which have recently been joined by well regarded multiple cable connectors, tip plugs and jacks—former Mallory-Yaxley products now manufactured and sold by JOHNSON. For a large and proven line of standards from which to choose look to JOHNSON.

If your requirements necessitate a special part or modification of a standard, you will be well accommodated. Many of the parts illustrated are "modified standards", others are completely special. It isn't so difficult here, for the complete plant facilities at JOHNSON reduce to a minimum reliance upon outside aid and the associated expense and delay. JOHNSON is especially well equipped to furnish complete assemblies of plugs and jacks, using any insulating material, and in combination with other metal parts.

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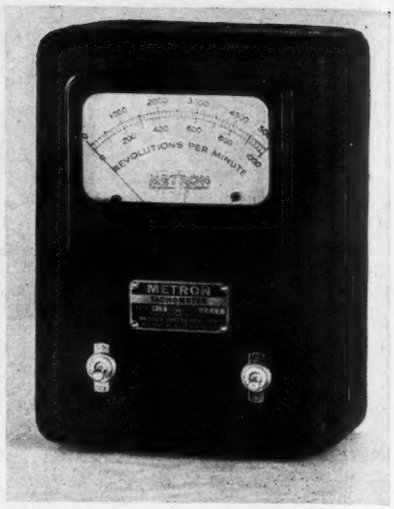
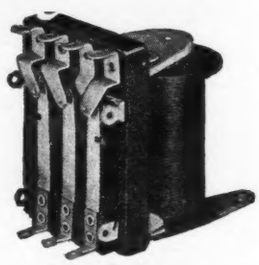


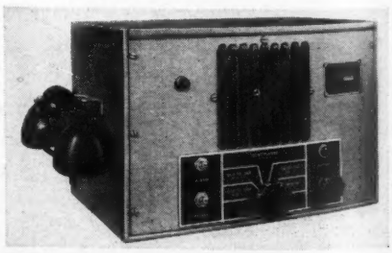
Tachometer

A complete line of electric switchboard tachometers working on a new principle have been brought out by Metron Instrument Co., 430 Lincoln St., Denver 9, Col. The head of these instruments consists of simple contact-making mechanism connected to the indicating unit by cable. The oscillating impulses charge a condenser through a meter, which reads average current. The instruments operate at 115 volts ac.—Electronic Industries



Shockproof Relays

A line of two and three pole relays having shockproof action under stress as high as ten times gravity has been developed by Kurman Electronics Corp., 35-18 37 St., Long Island City 1, N. Y. The armature of these units is insulated from the contact arms by a bakelite link, reducing chatter and providing a dielectric strength of 1500 volts between all contacts and ground. Contacts are rated to carry 2 amps at 100 watts.—Electronic Industries



Marine Radio Telephone

Islip Radio Mfg. Corp., Islip, Long Island, N. Y. has developed a compact 10" watt marine radio telephone. MRT 10 has two crystal controlled fixed frequency channels for transmission and reception and provides for individual final amplifier and antenna tuning adjustments for each channel. Power supply is available for either 6 or 12 or 32 volts dc. The unit is treated against corrosion and moisture.—Electronic Industries

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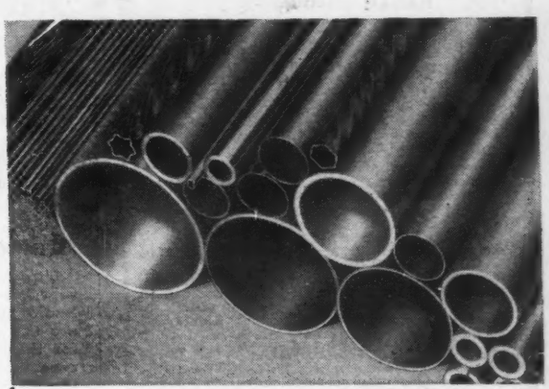

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.25 mfd 1000 vdc (G.E. Pyranol) ..... .40
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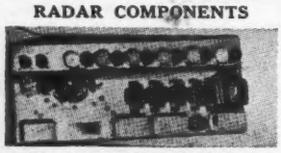

UHF Receiver BC-406. From SCR-268. Freq. Range: 201 to 210 mcs. 15 tube superhet. (continuous sweep, motor-driven, if desired) 29.95
Oscilloscope, 5", BC-412, from SCR-268. Operates on 115 vac, with conversion dia. and instr. 54.50
Signal Generator, BC-78-B made by Boonton. 15 to 55 mc; 190 to 230 mc. used, perfect condition 45.00
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U.S. NAVY Model RAK-7 shipboard receiver, NEW—in cases. Made by R.C.A., 15 kc to 600 kc, 6 bands. With 9 tubes, including regulated power supply, operating on 115v/60 cycles 77.50

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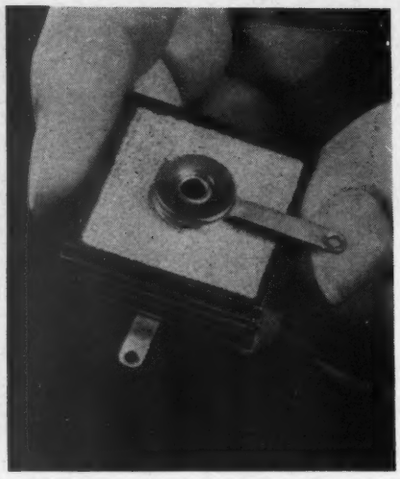
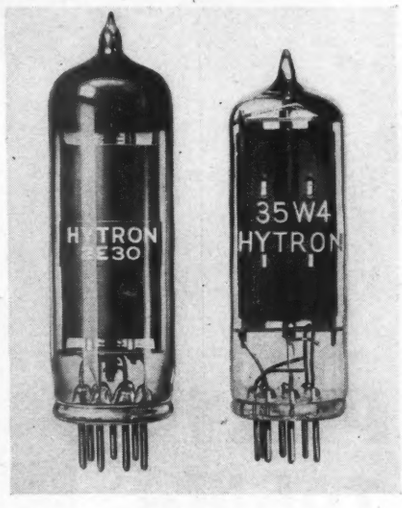


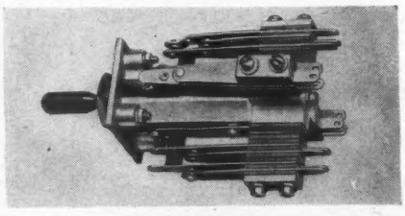
Midget Selenium Rectifiers

A midget size, 5 plate, square stack selenium rectifier to be used in place of rectifier tubes for ac-dc portable radio receivers has been brought out by Federal Telephone and Radio Corp., Newark, N. J. The unit which is rated at 100 ma dc and 330 volts peak inverse voltage.—Electronic Industries



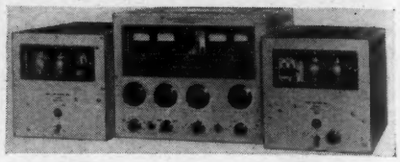
Miniature Tubes

Two new types in the series of miniature tubes recently brought out by Hytron Radio and Electronics Corp., Salem, Mass., are the 35W4, which is a replacement type for the 35Z5GT and the 2E30 (development type HD59). A heater tap is provided in the 35W4 for the operation of a panel lamp. The 2E30 is a beam tetrode designed for use in hf mobile equipment as af amplifier, class C oscillator and frequency multiplier.—Electronic Industries



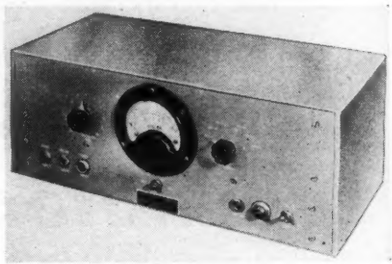
Cam-lever Switch

A 5-position cam-lever switch for single hole mounting of the switch frame to the panel and single bolt assembly of the contact block to the switch frame for ease in assembly and wiring is being manufactured at General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass. Contacts are silver, rated at 10 amps., 125 volts ac, non-inductive load.—Electronic Industries



Amateur Transmitter

An unusually compact one kilowatt (input) amateur fone transmitter has been developed by Taylor Western Transmitters, Inc., 6127 South Western Avenue, Los Angeles, Cal. The complete equipment is in three cabinets, two of which hold power supplies. Modulation in excess of 100% is based on a high efficiency system developed for use by the armed forces. Tube line-up in the rf section is a 6V6 oscillator, 6V6 doubler, 3D23 doubler or amplifier and an Eimac 4-250A beam power tetrode in the final. Audio consists of a 6V6 first speech, an 807 and a second Eimac 4-250A as a positive modulator. This positive modulator is biased to approximately three to four times class "C" and at carrier operation draws practically no plate current—the approximate 700 watts of carrier power being supplied by the first Eimac 4-250A to the antenna. Upon modulation, the first 4-250A as power amplifier adjusted to maximum output efficiency, is grid modulated downward from carrier level by the negative audio supplied by the 807 and causing negative modulation of the carrier. During this function the second 4-250A is inactive because of its high bias. With the completion of the negative modulation cycle, and carrier level restored, the 807 tube supplies positive audio voltage to the grid of the second 4-250A, as positive modulator, triggering it into operation to supply the positive or upward modulation above carrier level. With the completion of the upward or positive modulation one-half cycle, carrier level is again restored and ready for the second complete cycle of modulation as described above. Band change operation in five bands is provided.—Electronic Industries



Frequency Meter

For accurate frequency measurement of any type of electrical wave in the 10 to 20,000 c/s range, Communication Measurements Laboratory, 120 Greenwich St., New York 6, N. Y., offers Model 1800 A-F frequency meter and tachometer. Three input circuits provide for measurement of simple or complete periodic waves of 50 to 100,000 micro/sec duration, positive or negative pulses of less than 1 micro/sec or more than 50 micro/sec and tachometer measurement of rotating machinery. Frequency accuracy is better than 0.2% over a wide range of temperatures and mains voltages, when calibrated against an accurate 60 cycle supply. The suppressed zero type meter has a hand-calibrated logarithmic scale and a jack provides for use of an external meter or graphic recorder.—Electronic Industries

Electrical Connector

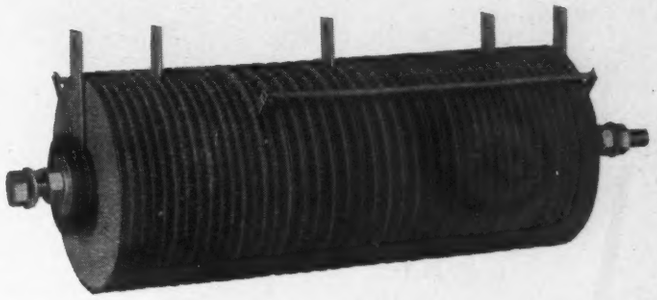
A new series of small multi-contact electrical connectors—plug and receptacle—for low level sound uses has been designed by Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal. The type XL connector is provided with a latch lock device and removable inserts with tapped metal armor for insert retaining screw.—Electronic Industries

38,000 *rectifiers per lb*

Selenium Rectifiers 4 volts 0.1 milliamperes d-c

Selenium Rectifier Stack 110 volts 5 amperes d-c

5 *lb per rectifier*



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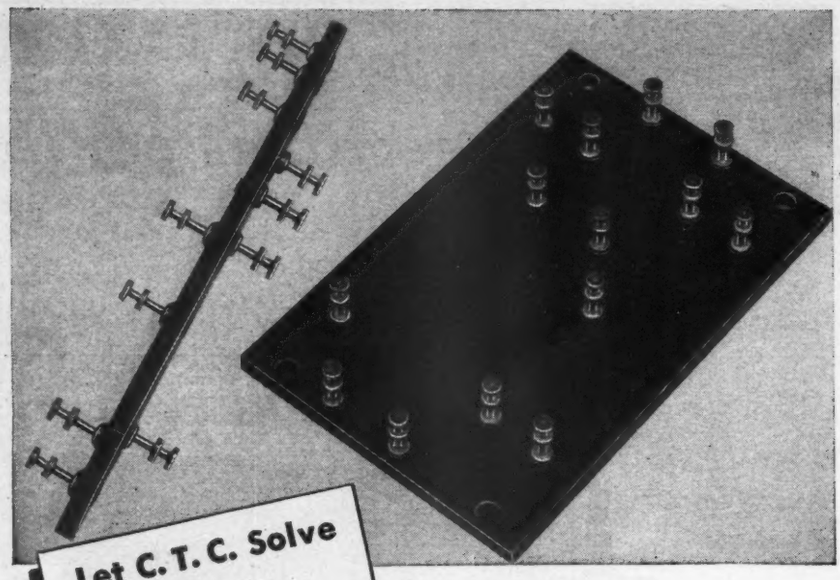
Selenium rectifiers, withstand extreme variations in ambient temperature, humidity, and pressure. Low leakage factor insures maximum operating efficiency.

For information that will help you make efficient use of G-E selenium rectifiers in your designs, write for our booklet "G-E Selenium Rectifier Stacks." Section **A-10-7124**, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn.

GENERAL ELECTRIC



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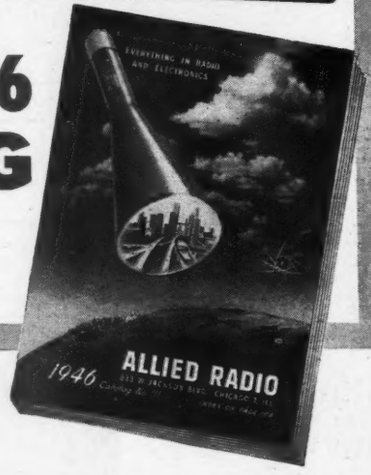

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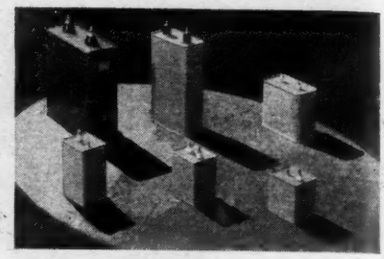


Storage Capacitors

A line of small, lightweight, dc pyranol capacitors for use in flash-photography, light-metal welders and similar applications has been developed by General Electric Co., Schenectady 5, N. Y. The capacitors are available in a wide variety of ratings ranging from 25 mf, 2000 V dc with 50 Watt-sec. storage capacity of 25 mf, 7000 V dc and 613 Wattsec. capacity. Dual-units are also available.—Electronic Industries

Expandable Amplifiers

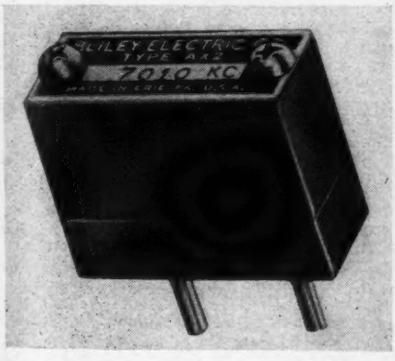
Multiamp amplifiers, produced by Concord Radio Corp., 901 West Jackson Blvd., Chicago, are so designed that with either a 30- or a 45-watt basic unit, additional input and booster units may be added quite simply without alterations or skilled help. Basic units provide two mike and two phono inputs with outputs from 1.3 to 600 ohms and the usual tone controls. Tubes are 2-7B4, 1-7F7, 1-7A4, 4-6V6, 2-6 X 5. Input stages, which, like the boosters, may be added with a screwdriver, are a four-channel unit and a six-channel unit. There are five booster units of 30, 45, 60, 75 and 90 watts output as well as a phono top, record changer top and volume level indicator, each unit self-contained and to be added easily. Other units include separate power stages of 30 and 45 watts output.—Electronic Industries

Pulse Generator

Radar Engineers, 4004 Arcade Bldg., Seattle 1, Wash., have designed a pulse generator type PG-2 which is continuously variable in three ranges from one to one thousand microseconds. Useful for television testing, as radar pulse or gate or general laboratory work the generator provides pulse amplitudes variable from 0 to 16 volts positive or negative at a repetition rate up to 2000 cps. The unit operates from the 115 volt, 60 cycle line.—Electronic Industries

Lightweight 'Scope

A 5½ lb. cathode-ray oscilloscope having complete vertical and horizontal deflection amplifiers, a 30 to 50,000 c/s time base oscillator and a 2 in. diameter screen, has been developed by Waterman Products Co., Inc., 2445 Emerald St., Philadelphia 25. This Model S-10-A "Pocketscope" occupies less than 0.15 cubic foot of space, but incorporates such features as a telescoping light shield, a twin-triode linear time base oscillator and complete switching facilities for direct or amplified deflection and sweep synchronization. Compactness is obtained by the use of miniature tubes.—Electronic Industries



Plated Crystal

A plated crystal for amateur frequencies having primary electrodes of micro-thin metal film deposited directly on the crystal surfaces is being manufactured by Bliley Electric Co., Erie, Pa. The design results in better grid current stability over a wide temperature range.—Electronic Industries

Improved Terminal Strip

A new type of component mounting strip providing the highest possible electrical characteristics and mechanical strength has been developed by Yates Engineering Services, Two Hampton Road, Cranford, N. J., for either fast production assembly or replacement use. Electrical properties have been improved by locating the mounting areas on finger-like projections. The need for soldering lugs or other metal inserts is eliminated and these new "YES" mounting strips can be had in glass, ceramics and rubbers as well as in laminated plastic.—Electronic Industries

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Mobile Radio

Importance of mobile radio equipment in the electronic field is emphasized by the fact that FCC lately has approved applications involving 40 land stations and some 650 portable mobile units with equipment to be supplied by five manufacturers. Following are the companies who plan to use portable mobile equipment together with the number of fixed and portable stations they will use and the make of equipment to be put in service:

Southeast Taxi Co. .....Southgate, Cal.
1 land station; 22 mobile units (Motorola)

Red's Taxi Co. .....Aberdeen, Wash.
1 land station; 8 mobile units (Motorola)

Kennedy & Sons.....(Detective Agency)
2 mobile units (Communications Equip. Co.)

Liberty Cab Corp. .....Evansville, Ind.
1 land station; 35 mobile units (Motorola)

City Yellow Cab Co. .....Akron, Ohio
1 land station; 2 mobile units (Morotola)

Hanford Taxi Service.....
1 land station; 9 mobile units
(Communications Equip.)

Red Cab, Inc. .....Indianapolis, Ind.
1 land station; 1 mobile unit (Link)

Yellow Cab Co. .....Memphis, Tenn.
1 land station; 25 mobile units (RCA)

Triangle Cab Co. .....El Paso, Tex.
1 land station; 10 mobile units (Motorola)

City Car Co. .....Madison, Wis.
1 land station; 50 mobile units (Motorola)

"A" Ambulance Service.....Brooklyn, N. Y.
1 land station; 3 mobile units (Link)

Strop Taxi Co.....
1 land station; 35 mobile units (Link)

Yellow Cab Co. .....Twin Falls, Idaho
1 land station; 5 mobile units (Motorola)

The U-Drivitt Auto Rental Co. Inc.....
3 mobile units (Federal)

Green Top Taxi Service.....Tacoma, Wash.
1 land station; 8 mobile units (Motorola)

City Taxi Service .....Visalia, Cal.
1 land station; 9 mobile units
(Communications)

George W. Nicely.....New Castle, Ind.
1 land station; 12 mobile units (Motorola)

Longhorn Taxi Co. .....Port Arthur, Tex.
1 land station; 4 mobile units (Motorola)

Norman Carver .....Wausau, Wis.
1 land station; 8 mobile units (Motorola)

Fort Wayne Safety Cab. Co.....Ft. Wayne, Ind.
1 land station; 60 mobile units (Link)

Decatur Transit .....Decatur, Ala.
1 land station; 28 mobile units (Motorola)

Hotel Boise Cab Co.....Boise, Idaho
1 land station; 16 mobile units (Motorola)

Black & White Cab Co.....Terre Haute, Ind.
1 land station; 20 mobile units (Motorola)

City Taxi Service .....Porterville, Cal.
1 land station; 6 mobile units
(Communications)

Diamond Taxi .....Lowell, Mass.
1 land station; 3 mobile units (Motorola)

Acme Taxi Co. .....West Palm Beach, Fla.
1 land station; 6 mobile units (Motorola)

L. L. Walsh .....Morristown, N. J.
1 land station; 10 mobile units (Link)

Rite Rate Cab Co. Inc.....St. Petersburg, Fla.
1 land station; 25 mobile units
(Communications)

Pattons, Inc. .....Austin, Tex.
1 land station; 35 mobile units
(Communications)

Youngstown Radio Cab Co.....Youngstown, Ohio
1 land station; 36 mobile units (Link)

Community Transit Co.....Helena, Mont.
1 land station; 6 mobile units (Motorola)

Silver Streak Cab Co.....Lewiston, Idaho
1 land station; 10 mobile units (Motorola)

Peoria Yellow Cab Corp.....Peoria, Ill.
1 land station; 10 mobile units (Motorola)

Broadway DeLux Cab Co.....Portland, Ore.
1 land station; 50 mobile units (Motorola)

Merlyn I. Edwards.....Waukesha, Wis.
1 land station; 18 mobile units (Motorola)

Yellow Cab Co.....Alexandria, La.
1 land station; 1 mobile unit (RCA)

Stedman's Taxi Service.....Waterville, Me.
1 land station; 3 mobile units (Motorola)

Black and White Cab Co.....Texarkana, Tex.
1 land station; 10 mobile units (Motorola)
Wilmington Cab Co.....Wilmington, Cal.
1 land station; 15 mobile units (Communications)
Radio Cab Co.....Lynchburg, Va.
1 land station; 16 mobile units (Link)
AA Radio Taxi.....Mt. Vernon, N. Y.
1 land station; 4 mobile units (Link)
Yellow Operating Co.....Miami Beach, Fla.
1 land station; 34 mobile units (Motorola)
Royal Cab Co.....Connersville, Ind.
1 land station; 6 mobile units (Link)

Tube Developments

A symposium on wartime tube developments and their commercial applications was held in the auditorium of the Engineering Societies Bldg. at 33 W. 39th St., New York City, on April 6 by the New York Section of the IRE. The principles and applications of many hitherto classified wartime developments were discussed in a number of papers.

"Selected Topics on the Uses of Magnetrons", was presented by W. B. Hebenstreit, (Bell). An analysis of a number of proposed ways of utilizing velocity modulated electron beams, together with historical and current illustrations of practical methods, was contained in "A Survey of Velocity Modulation Processes" by Morris Relson, (Sperry). The two major systems using velocity modulation classed as "velocity segregation" and "velocity grouping" and their variations were analyzed in detail, together with descriptions of the appropriate tube types in each classification.

C. C. Wang, (formerly with Westinghouse), presented "Velocity Modulation Oscillators with Secondary Emission Characteristics" in which secondary emission Klystrons were compared to reflex Klystrons and the characteristics of the 2K51-53 series of secondary emission velocity modulation oscillator tubes were given.

The "Cyclophone—A Multipurpose Electronic Commutator Tube" was discussed by D. D. Grieg, J. J. Glauber and A. M. Levine (Federal). The theory of operation and construction of a number of devices utilizing a beam of electrons as the switching element were explained, including their use in pulse time modulation. The most effective countermeasure against enemy radar, a microwave tube operating continuously at 50 kw was the subject of a discussion on the "Principles of Operation of the Resnatron" by F. W. Boggs, (Westinghouse). The resnatron, in contrast to other hf generators, operates with a substantial transit time by use of resonant cavities in the va-

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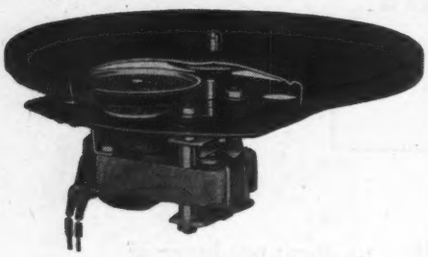

For quick starting, uniform speed and quietness, equip your new phonographs and record-changers with *Smooth Power* motors. From the wide and modern GI line, accurately and carefully built, you can select exactly the right motors for your needs.

Then you'll be sure of giving your customers that smooth, all 'round performance that builds good will . . . and sales. For motors you can always depend upon, *standardize on Smooth Power.*

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cuum envelope and an unusual design of its grid. G. T. Ford (Bell) presented a paper on "A Miniature Tube for Broad IF Amplifiers" relating to miniature type high Gm tubes such as the 6AK5.

L. S. Nergaard, D. T. Burnside and R. P. Stone (RCA Labs) described the pulse and cw performance of "A Developmental Pulse Triode for 200 kw output at 600 mc". The peak power output of the A-2212, which was developed for use in search radar, is approximately 200 kw at 600 mc with 0.1% duty cycle on a 5 microsecond pulse.

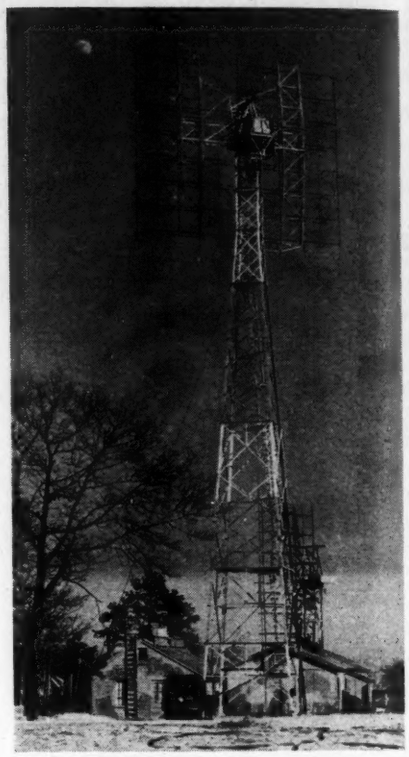
Brownell Opens Lab

H. Russell Brownell, formerly with the vacuum tube engineering department of the Western Electric Co., has opened his own consulting offices at 188 West Fourth Street, New York City. Laboratory facilities are available for electrical, electronic and magnetic testing and measurement, instrument calibration and repair, limited production of special equipment and for research and development.

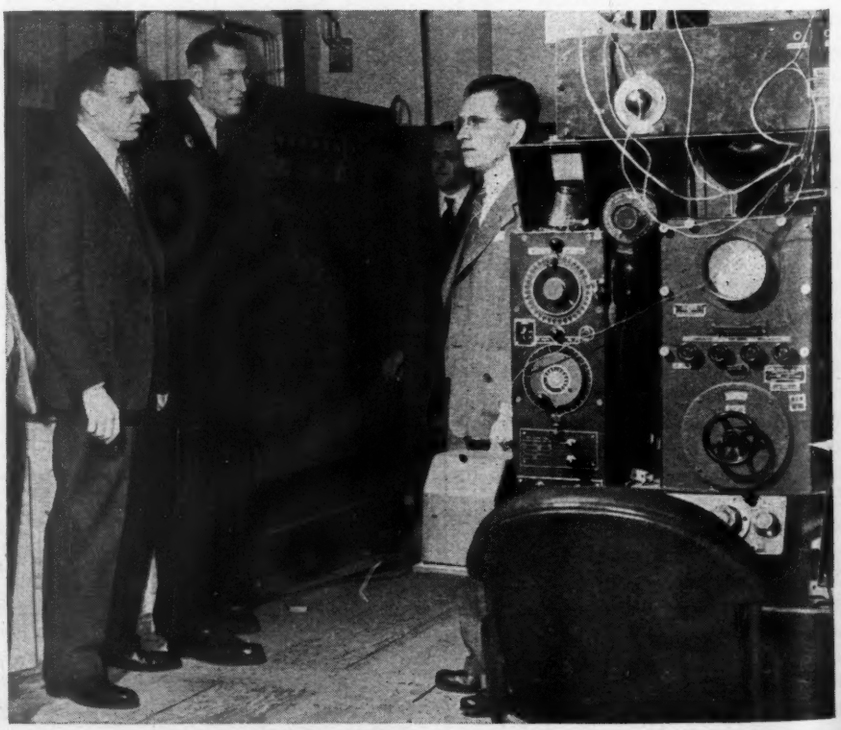
New Plant for Mastercraft

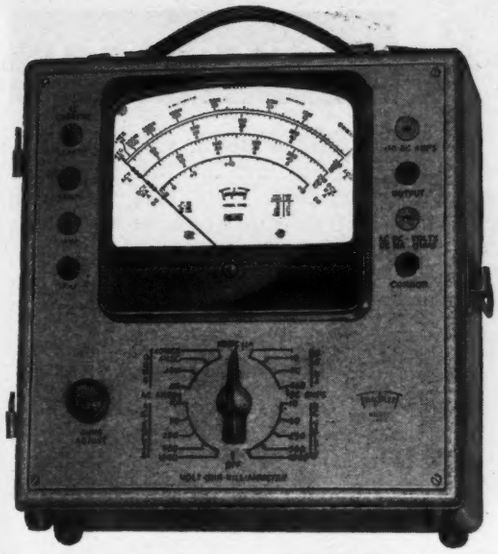
Mastercraft Electric Company, Inc., has moved to its new plant at 181 Bruce St., Newark 3, N. J. General offices will be located in the plant also to facilitate coordination of all phases of the business.

MOON RADAR



For "Project Diana" Signal Corps engineers used two SCR-271 arrays connected to operate as a single array. Below are some of the Evans Signal Laboratory engineers who conducted the test which bounced radar signals back from the Moon. Left to right they are: Dr. Harold D. Webb, Jacob Mofenson, Herbert P. Kauffman and E. King Stodola. The photo shows one corner of the laboratory where for several weeks a small group of engineers set up equipment in preparation for the experiment. The cathode ray tube on which the echoes were made visible appears in the rack directly behind the desk





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NEW "SQUARE LINE" metal case, attractive tan "hammered" baked-on enamel, brown trim.

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- READABILITY—the most readable of all Volt-Ohm-Milliameter scales —5.6 inches long at top arc.
- RED•DOT LIFETIME GUARANTEE on 6" instrument protects against defects in workmanship and material.

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30 RANGES

Voltage:	5 D.C. 0-10-50-250-500-1000 at 25000 ohms per volt. 5 A.C. 0-10-50-250-500-1000 at 1000 ohms per volt.
Current:	4 A.C. 0-.5-1-5-10 amp. 6 D.C. 0-50 microamperes — 0-1-10-50-250 milliamperes—0-10 amperes.
4 Resistance	0-4000-40,000 ohms—4-40 megohms.
6 Decibel	-10 to +15, +29, +43, +49, +55
Output	Condenser in series with A.C. volt ranges.

Model 2400 is similar but has D.C. volts Ranges at 5000 ohms per volt.

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RANGE OF Q MEASUREMENT: 80 to 1200
Q CAPACITOR RANGE: 11-60 mmf; accuracy ± 1% or 0.5 mmf, whichever is greater

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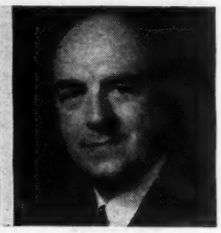
PERSONNEL

Dr. Ralph Bown, assistant director of research at Bell Telephone Laboratories since 1944, has been named director of research for that organization. Dr. Bown, internationally recognized for pioneer research and development work in the field of communication engineering, has been associated with the Bell System since 1919. He succeeds Dr. M. J. Kelly who has been serving both as director of research and executive vice president of the Laboratories and who will continue in the latter capacity.

Dr. Ralph Bown


George L. Best

George L. Best, who has been assistant vice president of the American Telephone and Telegraph Co., has been elected vice president of the Western Electric Co. He joined the Bell System as an assistant engineer in the New York Telephone Company's Commercial Department in 1922.

J. Russell Stewart has returned to the engineering division of the Stromberg-Carlson Co., Rochester, N. Y., after a stretch with the U. S. Army Signal Corps. His work will involve the development of carrier current telephone equipment.

Glenn E. Webster has been appointed chief engineer of the Turner Co., Cedar Rapids, Iowa. He was formerly in charge of the company's speech equipment engineering.

Commander Hugh E. Allen, has joined Telephonics Corp. in New York as manager of electronics engineering and sales. Since August, 1943, he has been with the Bureau of Aeronautics, assigned to the radio-electronics branch of the engineering division. His last work before joining the Navy was chief engineer in charge of production for Harvey-Wells, Inc., Southbridge Mass.

Dr. James W. McRae, electro-visual engineer for Bell Telephone Laboratories, has been appointed director of radio projects and television research for that organization. Dr. McRae has recently been released from active duty as a colonel in the Army Signal Corps where his last assignment was as deputy director of the engineering division of the Signal Corps Engineering Laboratories. He was previously associated with the development of airborne radar and radio and radar countermeasures, and at one time he served as Acting Chief of the Electronics Division in the Office of the Chief Signal Officer. In recognition of his services he has been awarded the Legion of Merit. He became associated with the Laboratories in 1937 when he undertook research on transoceanic radio transmitters at the Laboratories Deal, N. J., location. In 1940, he turned to a study of microwave technics.

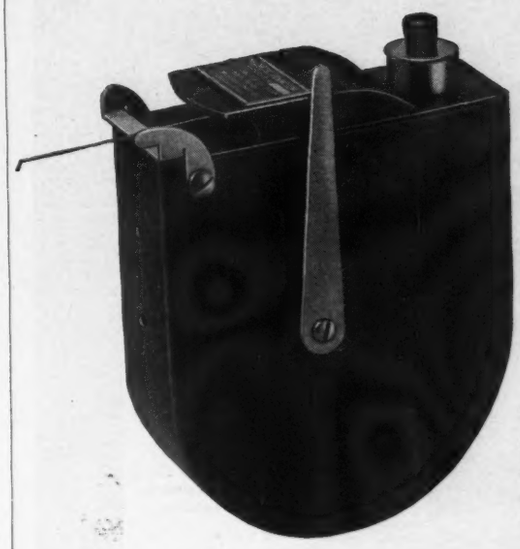
Dr. James W. McRae Virgil Graham

Virgil M. Graham has been made manager of technical relations for Sylvania Electric Products Inc. He was formerly manager of the Sylvania industrial apparatus plant at Williamsport, Pa., and joined the Sylvania engineering staff eleven years ago.

Dr. David S. Saxon has joined the research staff of Philips Laboratories, Inc., as an associate physicist and is in charge of the Section on Theoretical Physics. At present he is working on the theory of the stability of high energy particle accelerators such as the synchrotron and frequency modulated cyclotron.

Henry C. Sheve has been appointed Stromberg-Carlson staff engineer. He joined Stromberg-Carlson in 1925 as a radio engineer. Later he was placed in charge of the physical testing laboratory and was granted a leave of absence two months before Pearl Harbor to enter the U. S. Navy as a lieutenant; left the Navy as a commander.

Brush Magnetic Oscillographs

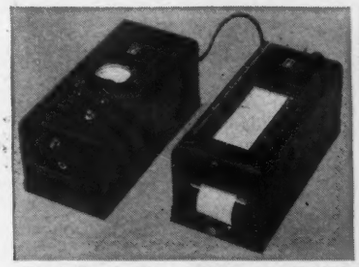


make direct-writing recordings from D. C. to 100 cycles per second!

The remarkable new Brush Magnetic Recording Pen Motor—heart of the Brush Direct-Inking Oscillograph. Highly stable. May be used under virtually any climatic or temperature conditions. Exceptional accuracy.

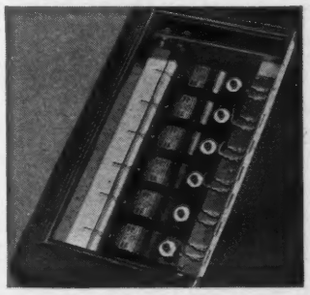
● *Instantaneous, permanent, ink-on-paper* recordings by Brush Oscillographs make their use almost unlimited. Accurate recordings of strains, pressures and countless electrical phenomena can be made over a frequency range of *D.C. to 100 c.p.s.* Either A.C. or D.C. circuits can be measured. Whenever desired, recordings may be stopped for notations on chart-paper.

Brush Oscillographs are compact, portable and ruggedly constructed for ease of handling and operation. Investigate them now. Brush engineers will gladly co-operate in determining their application to your problems. Write for technical bulletin No. 593 for complete details of this equipment.



Brush Single-Channel Magnetic Oscillograph with amplifier. Especially suited for counting, temperature recording, surface analysis—and similar applications. Three-speed paper drive, 5, 25, 125 mm per second. Chart paper 2⅜" wide.

Brush Double-Channel Magnetic Oscillograph for use where two simultaneous recordings are desired—as in synchronizing problems. Three-speed paper drive, 5, 25, 125 mm per second. Chart paper 3 15/32" wide.



Brush Six-Channel Magnetic Oscillograph. Excellent for strain-gauge recordings. Dust-proof case. Interchangeable gear paper drive. Your choice of paper speeds from ⅛" to 5" per second. Chart paper 12" wide.

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IDEAL FOR AMPLIFYING STRINGED INSTRUMENTS
USED WITH ANY AMPLIFIER AND WITH RADIO SETS.
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561 BROADWAY NEW YORK

Robert B. Albright has been made principal engineer, now heads laboratory operations of the Bendix Radio Division of the Bendix Aviation Corp., Baltimore, concentrating on the electrical design of broadcast receivers. Following several years spent with RCA, Albright joined the Philco Corp., for export set design. Later he became associated with domestic broadcast radio and radio-phonograph development.

R. B. Albright W. L. Jenkins

William L. Jenkins has been appointed manager of the recently created electronic applications development department of The B. F. Goodrich Co. He joined the company in 1940 and for the last several years had been an experimental engineer.

Arthur L. Samuel, an authority on vacuum tubes, currently connected with Bell Telephone Laboratories, has become a member of the electrical engineering faculty at the University of Illinois, Urbana. Since 1931 he has been engaged in research work on vacuum tubes for ultra high frequency work.

A. D. Haedecke has been named designing engineer and **R. F. Shea** engineering consultant in the Specialty Division of General Electric Co's Electronics Department. Haedecke will be responsible for the electrical and mechanical design of the division's products. Shea will act as advisor on technical and engineering problems for the division. Both men will make their headquarters at the Wolf Street plant in Syracuse, N. Y.

A. J. Monack, Rutherford, N. J., has resigned as engineering vice president and a member of the board of directors of the Mycalex Corp. of America in order to engage in consulting services on glass, glass-metal seals, and electronic insulation. He served with the University of Illinois, Western Electric Co., and Radio Corp. of America prior to his engagement by Mycalex.

Cyrus T. Read has resigned from the engineering staff of Hallicrafters, Inc., to become supervising buyer of electronic equipment for Montgomery Ward & Co. in Chicago.

Col. John A. Proctor, president and director of the Oxford Radio Corp., Chicago, has been elected a director and vice-president of Mycalex Corp. of America. He was formerly associated with General Electric Co.

Richard C. Darnell, consulting engineer on servomechanisms and other industrial electronic instrument designs, has been appointed by the Dept. of State to serve in China as a specialist in scientific instruments and laboratory equipment. He will assist in the selection of modern scientific instruments needed to replace those worn out or looted from universities and research organizations. He left for China early in June.

W. C. Eddy, director of television Station WBKB for Balaban and Katz in Chicago, has been recalled by the Navy Department for temporary duty as civilian consultant in connection with rebuilding the Naval Electronics Television program. He will be considered "on loan" for a period of a few months.

Webster-Chicago Exhibits

Webster-Chicago Corp. has recently occupied a new three-story addition to its plant, at 5610 Bloomingdale Avenue. It adds 60,000 sq. ft. of manufacturing space. Early in May the company was host to distributors and dealers from coast to coast, occasion being a showing of new record changers and other electronic products.

Tullo Leaves Zenith

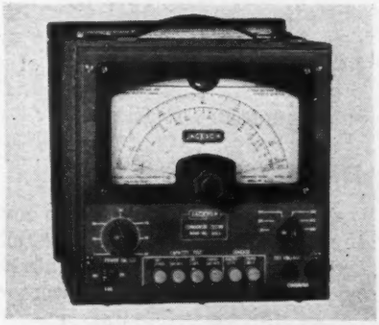
Harvey Tullo, until now vice-president of the Zenith Radio Corp., Chicago, has severed his connection with the company to head an organization of his own in the plastics field. He was in charge of purchasing for Zenith.

Sets Are Up 7%

According to the U. S. Census Bureau the number of homes having broadcast receivers has increased 7% since 1940. At the present time 90% of the country's 34 million homes have radio sets. The data is based on a 1945 sampling in 42 states.

DETECTS SMALL LEAKS

Condensers with even the slightest leakage will not get by this compact, modern tester. You get positive indication on the electron ray tube and the correct reading on the easy-to-read expanded scale.



CONDENSER TESTER MODEL 650-A

Range—.00001 to 1,000 mfds.

Automatic Push Button Controlled— Amazing in speed and simplicity of use. Capacity readings almost instantaneous! Leakage test by just pressing a button.

The Model 650 is a modern accurate and complete instrument for detecting faulty condensers—Electrolytic, Paper or Mica. New method for Leakage Test reveals otherwise unnoticed condenser defects.

Scale is Glass Enclosed and is equipped with the new Jackson Scale Expander indicating pointer — doubles effective scale length.

Measures All Values—Direct reading in Microfarads.

Ranges

.00001 to .001 mfd.	.1 to 100 mfd.
.001 to .1 mfd.	50 to 1000 mfd.

Measures Power Factor on direct reading dial. Power Factor range calibrated from 0 to 60%.

Complete Selection of Test Voltage. 20 volts to 500 volts.

Electron Ray Tube indicates exact balance or shows if leakage is present.

Instantaneous Leakage Indication— Counting of flashes eliminated. No other guess-work with this modern tester. Has special built-in amplifier stage which actually responds to slightest leakage, if present. Thus all leakage defects may be located.

JACKSON

Fine Electrical Testing Instruments

JACKSON ELECTRICAL INSTRUMENT COMPANY, DAYTON, OHIO

★ Clarostat Series MT tube-type resistors remain the ideal voltage-dropping means in AC-DC receivers and other compact electronic assemblies. Handy. Compact. Inexpensive. Identical in size, shape, appearance and mounting to the 25Z6 and 25A6 metal radio tubes. Also readily serviced out in the field with Clarostat replacements.

This type provides connections to "hot" leads under the chassis, yet dissipates the heat above it.

Exceedingly high leakage resistance — well over 1000 megohms under adverse conditions —between resistance element and chassis, permits use in the most sensitive circuits without introduction of AC hum.

Terminal connections and leakage resistance meet Underwriters requirements.

Available in a wide range of pilot lamp combinations.

Resistance element comprises coiled resistance winding supported on notched mica form. No sagging. No shorts.

★ *Write for DATA . . .*

Clarostat Engineering Bulletin 107 contains all necessary technical details. Write for your copy. And submit that resistance or control problem!

CLAROSTAT Controls and Resistors

CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

Voltage Regulation

A short engineering treatise on ac voltage and current regulation and control has been issued by Sorenson & Co., 375 Fairfield Ave., Stamford, Conn. Mechanical and magnetic regulators are compared with the elecronic types and the Sorenson system of regulation which requires no moving parts is described. Engineering data, photographs and dimensional sketches of four models giving quick response, independence of frequency and power factor, minimum waveform distortion and constant output voltage independent of load are included. Also described are variable voltage autotransformers.

Solenoid Valve

The V5-200 Solenoid Valve for use with CO_2, air, water, hydraulic fluids and other media is shown and described in a new bulletin issued by the Allied Control Valve Co., Inc., South Norwalk, Conn. The V5-200 is available for ac or dc operation, intermittent or continuous duty, rated at 10 watts max. Leaks are eliminated by use of soft seats and the coils are impregnated to be moisture resistant.

Decade Units

A descriptive 8-page folder covering decade units is being distributed by Harvey-Wells, Southbridge, Mass. The decade units were designed for experimental setups on dc or low frequency ac circuits. A variety of inductor units, resistor units, transformer units and capacitor units are available. A metal housing suitable to hold six large and two small decade units can also be provided.

Master and Foot Switches

General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass., is distributing two catalogs on "Master Switches" and on "Manually Operated Foot Switches". The 12 pg. master switch bulletin lists and describes a variety of lever switches, midget lever switches, rotary and rotary snap switches, push button switches and contact assemblies. The 8 pg. foot switch catalog gives applications, specifications and dimensions for three styles and ten standard types of units.

Fuses and Lamps

Solar Electric Corp., Warren, Pa., has issued a 16 page catalog listing in addition to their regular line of incandescent lamps some newer fluorescent lamps, fluorescent starters, insecto lamps, eyease lamps, plug and cartridge fuses, dry batteries and germicidal lamps. The catalog gives photographs, descriptions, applications, specifications and prices for a wide variety of products.

Surface Pyrometers

Various types of surface pyrometers, widely used throughout industry, are described in a 12 page bulletin issued by Cambridge Instrument Co., 3005 Grand Central Terminal, N. Y. Roll, extension, mold and needle pyrometers are illustrated; their industrial applications and technical characteristics are given.

Ceramic Capacitors

Construction and specification charts for Hi-Q silver electrode ceramic capacitors of the CN and CI type are shown in two folders issued by the Electrical Reactance Corp., Franklinville, N. Y. The capacitors, which are a compound of titanium dioxide with ceramic material are custom made and applied to specification.

Protective Packaging

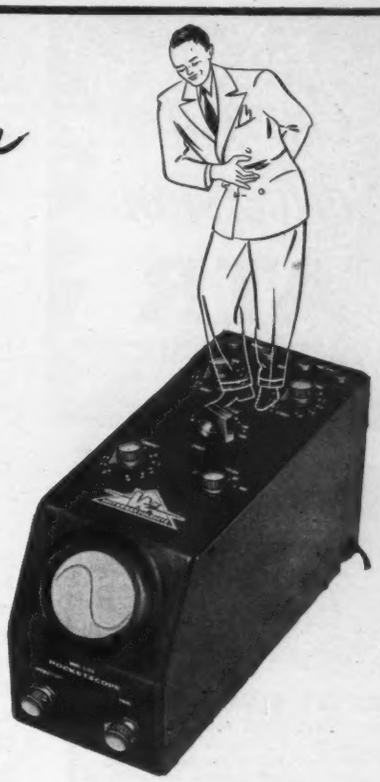
Aquastop, a synthetic, impregnated, coated and chemically treated packing liner fabric is in production at Protective Coatings Corp., 689 Main St., Belleville 9, N. J. The packaging is tough, flexible and waterproof and has a "breathing" property, since it allows moisture vapor to be transmitted.—Electronic Industries.

Wire-Stripping

Fairchild Camera & Instrument Corp., Jamaica, N. Y., has issued new data on its wire-stripping process. Formex and Formvar covered wires in sizes No. 36 to 44 may be stripped by this method as well as modern types of synthetic covered wires. Included are wires covered with enamels, nylons, etc., in sizes to No. 55. By dipping into two different chemical solutions and then gently stroking the wire, the insulation is removed in a few seconds. Wire size and physical properties remain unchanged. — Electronic Industries.

modestly...

We take a bow



Reception of POCKETSCOPE—the pocket-size oscilloscope—at the Chicago Radio Parts Show, was marvelous. For all the kind expressions of praise so generously given, we thank you.

Yet, with pardonable pride, we can appreciate the enthusiasm shown for this great little multi-use testing instrument. Although revolutionary in its small size (4" x 6⅜" x 10"), its light weight (5¾ lbs.) and its low price, it is so soundly engineered, so practical in the multiplicity of its uses and flexibility of positions, as to be readily recognized as a must in every laboratory, for every serviceman, for every engineer that appreciates the wide application of the complete oscilloscope.

FOR DELIVERY: contact your jobber. If he doesn't have the POCKETSCOPE available, contact us direct.

Midget in size... Giant in performance.

WATERMAN PRODUCTS

WATERMAN PRODUCTS CO., Incorporated, Philadelphia 25, Pa.

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Designed and produced to meet your specific requirements . . . not ordinary stock units. From blueprint to finished product . . . our years of engineering skill plus initiative and expert craftsmanship are your assurance of complete satisfaction.

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214 SOUTH STREET STAMFORD, CONN.

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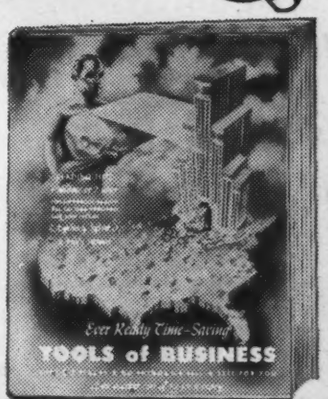

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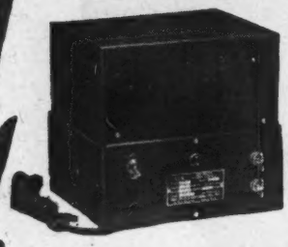

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BATTERY ELIMINATORS

FOR CONVERTING A.C. TO D.C.

New Models . . . designed for testing D.C. electrical apparatus on regular A.C. lines. Equipped with full-wave dry disc type rectifier, assuring noiseless, interference-free operation and extreme long life and reliability.

- Eliminates Storage Batteries and Battery Chargers.
- Operates the Equipment at Maximum Efficiency at All Times.
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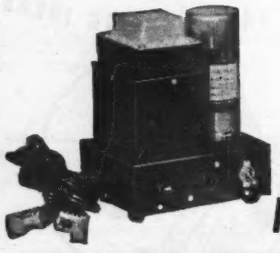

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LOW POWER INVERTERS

FOR INVERTING D.C. TO A.C.

Another New ATR Model . . . designed for operating small A.C. motors, electric razors, and a host of other small A.C. devices from D.C. voltages sources.

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STANDARD AND HEAVY DUTY INVERTERS

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Specially designed for operating A.C. radios, television sets, amplifiers, address systems, and radio test equipment from D.C. voltages in vehicles, ships, trains, planes, and in D.C. districts.

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Quality Products Since 1931

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Weston Notes

A new publication entitled "Weston Engineering Notes," which will serve as a medium to provide pertinent application engineering information for users of electrical indicating instruments, has been inaugurated by the Engineering Laboratories of the Weston Electrical Instrument Corp., Newark, N. J. The first issue featured articles entitled "The Galvanometer and the Bridge" and "Copper Oxide Rectifiers as Used in Measuring Instruments".

Industrial Instruments

Industrial process indicators, recorders and controllers are described in Catalog 370, issued by the Foxboro Co. of Foxboro, Mass. Instruments and accessories for the measurement and control of pressure, temperature, moisture, liquid level, specific gravity, flow, pH, speed, thickness, weight, time sequence and many other properties are illustrated, with brief specifications of each type.

Armour Activities

A 20-page pamphlet entitled "Industrial Research Progress at Armour Research Foundation of Illinois Institute of Technology, 1944-45," describes its facilities and activities in electronic research, as well as in the other major fields of physics, electrical and mechanical engineering, metallurgy, chemistry, etc. The Foundation is a non-profit institution established in 1936 to render a research and experimental engineering service to industry.

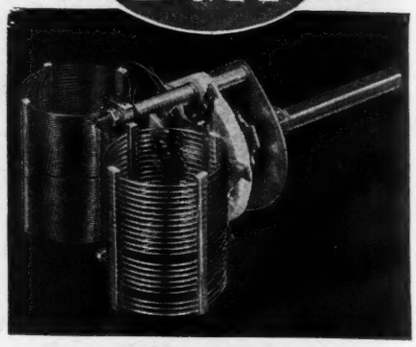
Heavy Duty Relays

An 8 page booklet has been issued by Ward Leonard Electric Co., Mount Vernon, N. Y., which describes the "Bulletin 130" heavy duty relays. Single pole, single break relays, single pole, double break relays, double pole, single break, three pole, four pole, double throw, latching relays and special types are illustrated. Photographs, dimensions and characteristics are included.

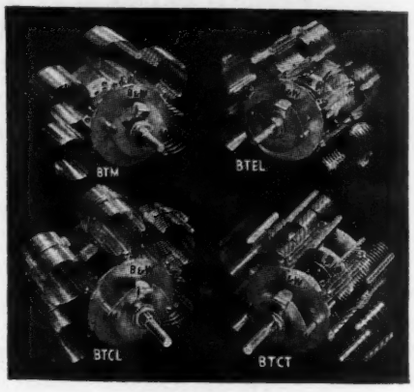
Switches

The new catalog from Centralab Division, Globe-Union Inc., Milwaukee 1, Wisc., covers a complete line of selector switches. Electrical characteristics, mechanical design and exact dimensions for proper mounting are shown for each of the

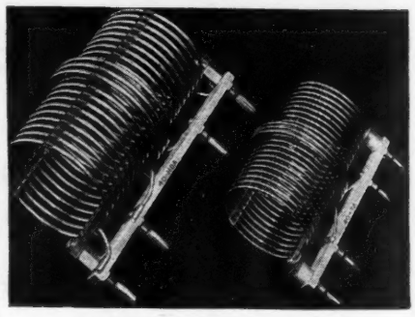
B&W



"BAND HOPPERS"



TURRETS



ANTENNA COILS

From amateur radio types to units for broadcast, r-f heating and other electronic uses, B & W offers a complete line of AIR INDUCTORS and assemblies for practically every requirement. Samples to your specifications on request, or send details of your application for recommendation based on standard B & W Inductor type.

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types made. Circuit and tap selector, tone control, lever action and special push and solenoid operated switches are described. A page is devoted to medium duty power switches. Insulation is either laminated phenolic or steatite with clips and contacts silver-plated brass or solid silver. AC line switches can be included with some segment combinations.

Steel Bellows

A twelve page booklet in color gives detailed specifications and a dozen possible applications of the stainless steel bellows made by Chicago Metal Hose Corp., Maywood, Ill. These units can be used as the movable member in electrical control instruments operating under pressure changes, thermostatic recorders, packless valves and as flexible connectors.

Cardioid Microphone

A four page folder issued by Electro-Voice, Inc., 1239 South Bend Ave., South Bend 24, Ind., explains the engineering details and operating characteristics of new cardioid polar pattern microphones. Unidirectivity is achieved by a supplementary phase shifting diaphragm which neutralizes pick-up except that originating in front of the unit. This feature reduces reverberation and random noise pick-up and permits almost double the usable speaker volume. A convenient switch allows the selection of either a flat or a rising treble response.

Wire Wound Resistors

A sixteen page bulletin, in color, fully describes all of the standard wire wound resistors made by Lectrohm, Inc., 5139 W. 25th St., Cicero 50, Ill. Exact resistance values, maximum current carrying capacities and types of terminal in both the fixed and adjustable models of these vitreous enameled units are given. Supplementary information outlines the characteristics to be watched for in the proper selection of both regular and special resistors. A page is devoted to the specifications of the two electrically heated soldering pots made by Lectrohm.

Glass Components

Three 4-page folders describing electrical glass components and their applications have been issued

For 15 years the name Haydon has stood for dependable accuracy in the timing of industrial operations.

Haydon Timing Devices (more than a million are now in use) are solving timing problems more efficiently and at lower cost for thousands of American manufacturers. Haydon Timing Devices include Repeat and Interval Timers, Contactors, Interrupters, Instrument Clocks, Elapsed Time Indicators, and other electrical apparatus for almost every conceivable timing operation.

Write today for complete specifications and information on Haydon Engineering Service.

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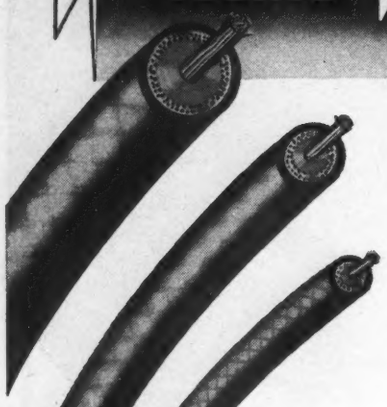

Development of formulations rigidly tested to meet exact specifications has made Surprenant a leader and authority in the field of plastics insulated, high frequency, low loss coaxial cable and tubing. A diversity of facilities, wide range research and engineering service, unexcelled laboratory equipment, and a wealth of experience enable us to match in every detail the requirements you name. We would appreciate the opportunity to furnish complete technical data.

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Surprenant
ELECTRICAL INSULATION CO.
84 Purchase St., Boston 10, Mass.

by Corning Glass Works, Corning, N. Y. The first illustrates the properties of metallized glassware using the hermetic glass to metal seal. Photographs and descriptions of tubes, bushings, coil forms, headers and instrument windows and typical applications are included. The second folder shows typical glass components for the electronic industry and gives physical and electrical specifications of electrical glasses. A third folder lists the properties, applications and advantages of the Vycor brand 96% silica glass.

Pressure Switches

Meletron Corp., 950 N. Highland Ave., Los Angeles 38, Cal., has issued a catalog illustrating pressure operated switches. Various models operate from near zero absolute in. of vacuum to 5,000 PSI. The catalog is designed to give data of a general nature and an Engineering Data summary sheet is included for specific problems to be submitted to the company.

Radio Components

National Co., Inc., Malden, Mass., is distributing catalog No. 600, listing communication receiver and complete units. The 20 page booklet gives illustrations, descriptions, prices and specifications of dials, precision condensers with micrometer dials, receiving and transmitting capacitors, rf chokes, shaft couplings, transmitter, exciter and buffer coil forms and other components. The several pages are devoted to descriptions of communication receivers. A price index is included.

Fixed Capacitors

Girard-Hopkins, Oakland, Cal., has published catalog 64, which is devoted to a wide variety of capacitors for industrial purposes. The booklet is divided into sections covering a number of types of dry electrolytic and wet electrolytic capacitors, paper tubulars, other types of paper capacitors, electrolytic replacements, interference filters, hermetically sealed by-pass capacitors and power factor correcting and transmitting capacitors. Prices, specifications, dimensions, an alignment chart for power factor capacitors and the RMA resistor color code are included.

Silicone Rubber

An engineering pamphlet explaining the mechanical, electrical

TOROIDAL COILS
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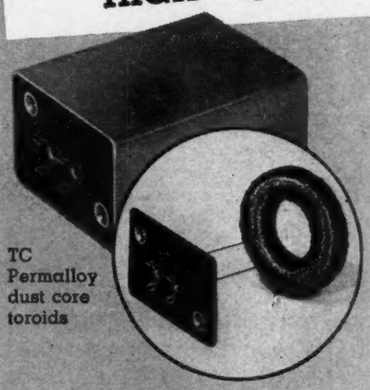

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"Q" as high as 150 at 3000 cy.
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Send at once to your jobber for a copy of the NEW Premax Catalog. It shows the complete line of Vertical Antennas in Steel, Aluminum, Monel and Stainless, as well as Corulite Elements and other elements for arrays. If your jobber can't supply you, write direct, giving us his name.

Premax Products
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4612 Highland Ave., Niagara Falls, N. Y.

and chemical properties of silicone rubber is being distributed by the Resin and Insulation Materials Div., General Electric, Schenectady. Although widely used, silicone rubber is still in the developmental stage. However, some of the available information and photographs illustrating its applications have been compiled in this informative booklet, which will be of interest to prospective users.

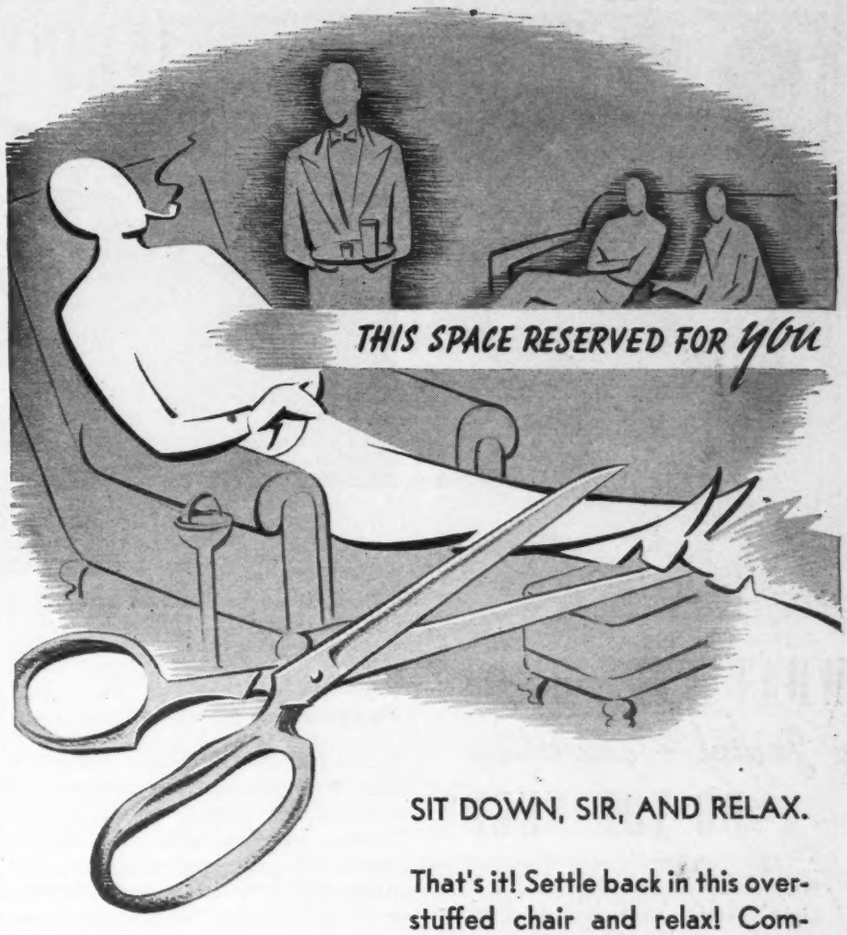
Infrared Parade

A booklet published by the Fostoria Pressed Steel Corp., Fostoria, Ohio, explains the infrared process which is widely used for multiple baking, drying, dehydrating and preheating tasks. Many photographs illustrate applications of infrared heating equipment indicate uses for the process. The theoretical background of the process as well as practical factors in installations are discussed in detail.

Complementary-Diversity Microwave Reception

Increase of transmitter power is inefficient compared with complementary diversity reception as a method for overcoming the fading of microwaves over most optical paths, according to a report on tests of radio relay equipment conducted for the U. S. Army Signal Corps. Comparative tests of radio relay equipment were conducted in California during the summer of 1945 as an outgrowth of experience with AN/TRC-6 equipment (4300-4900 mc). Three overwater and three overland optical paths were used in the tests. Complementary diversity reception eliminated the propagation outages on 78- and 102-mile overwater optical paths and resulted in circuits exceedingly free from noise.

A signal corps report explains that in complementary diversity reception, a second receiving paraboloid is vertically spaced, so that deep signal fades on one antenna are coincident with a strong signal on the other. The term "complementary diversity" is used because typical diversity signals on longer wave lengths usually aim only at securing random fading between signals derived from two or more antennas. In the tests, the two antennas were so placed that minimum signals of one antenna and maximum signals of the other coincided reasonably well. Hence the reception may be called "complementary" as well as "diverse."



SIT DOWN, SIR, AND RELAX.

That's it! Settle back in this overstuffed chair and relax! Comfortable, Ah-h-h-! Here, sir, is your scotch and soda. Now then, forget your business cares and worries, get ready to enjoy yourself — leave your troubles to Macallen. Because wherever Mica is used in any form, Macallen has the vast resources, the wide technical experience and the physical equipment to take care of your requirements perfectly.

If your product is generators or motors, transformers, condensers, switches or anything that requires Mica, you can rely on Macallen's more than half a century working with Mica. Get ready to enjoy yourself — leave your troubles to Macallen.

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THE MACALLEN COMPANY

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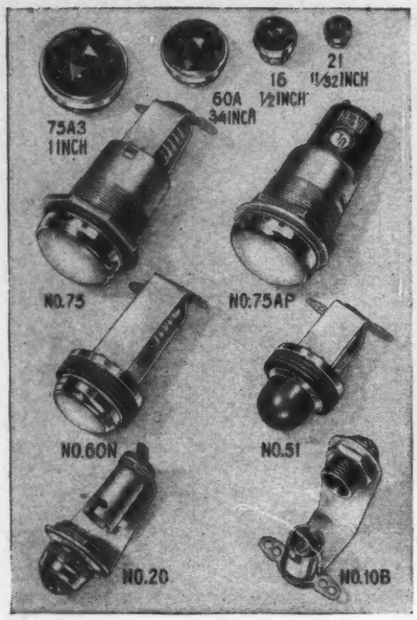

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No matter what type or size of Jewel Light Assembly you need, chances are we can produce it for you quickly, more satisfactorily, *and at lower cost!* Here, every facility is available for high speed quantity production . . speedy, efficient, economical service. Drake *patented features* add greatly to the value and dependability of our products.

You'll like the friendly, intelligent cooperation of our engineers. Let them help you with signal or illumination problems. Suggestions, sketches, cost estimates or asking for our newest catalog incur no obligation.

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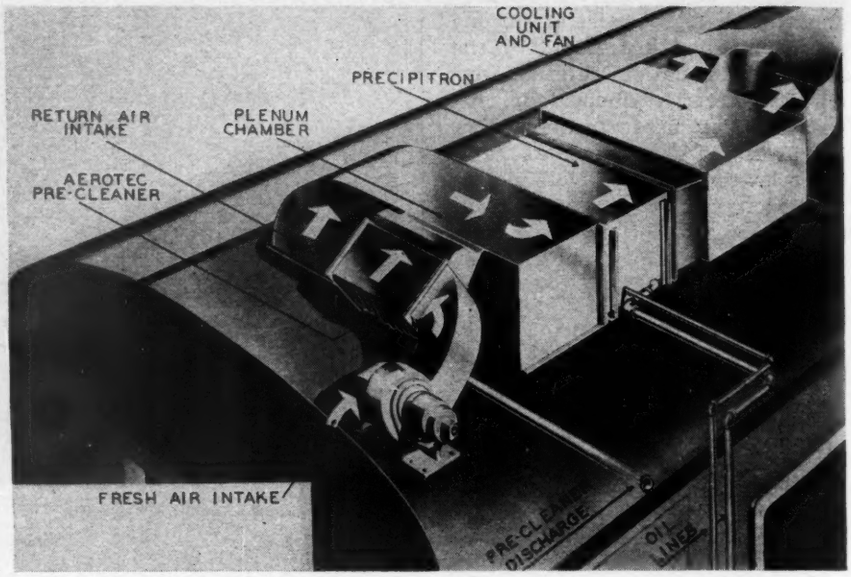


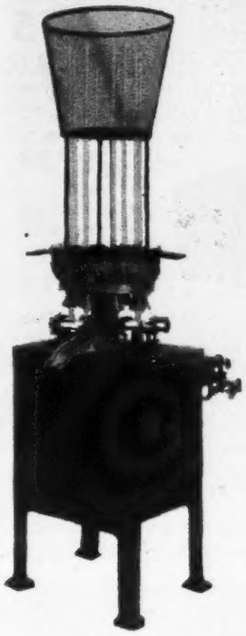
Schematic of the Westinghouse Precipitron showing arrangement for clearing smoke from railroad passenger cars

Smoke-Free Passenger Coaches

Another use has been found for the Westinghouse Precipitron. A railroad car which would accommodate smokers and non-smokers alike without annoyance to each other has been a problem occupying the railroads. This problem has been overcome by use of the Precipitron, an electrostatic air cleaner. The Precipitron is part of a general air cleaning system handling 600 cf of fresh air per minute and 1800 cfm recirculated air. The air is first passed through a mechanical filter that removes the bulky dirt and then through the Precipirton, which eliminates the finer particles. As a result more than 90% of the total dirt particles are removed. Cleaning of the unit is facilitated by an outlet beneath the coach to which it is only necessary to connect a hose and run a stream of oil through it. The precipitron consumes 75 watts and is located in non-revenue producing space in the coach.

G-E instantaneous vapor detector being used to check concentrations of mercury vapor in various locations in a laboratory. Equipment operates on the principle that ultraviolet light is scattered when it passes through atmosphere that contains mercury vapor, dangerous to health

BAACH-INTERNATIONAL



EIGHT HEAD HOT-CUT FLARE MACHINE

•

Automatic throughout.

Can be synchronized with automatic Stem machine.

Accommodates eight full lengths of glass tubing.

Cuts off and flares in one operation.

Production, 1000 flares per hour.

Made in two sizes: *Miniature machine,* for miniature flares and fluorescent starters, and *Standard machine* for standard size lamps, fluorescent and radio tubes.

Range of *Standard Machine:*

Glass tubing	35 to 42 gauge
Length of flares	5 mm to 80 mm
Forms flares up to	47 mm diameter
Net weight	1500 pounds
Boxed	1700 pounds

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Manufacturers of High Vacuum Pumps, Automatic Machinery for Incandescent Lamps, Electronic Tubes since 1916.

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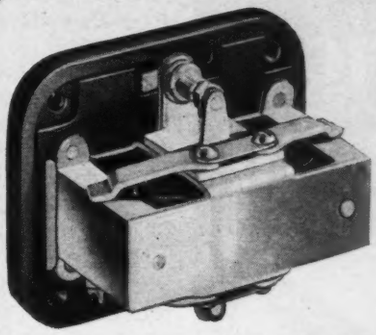

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This relay will handle currents up to 1 amp. with a sensitivity of less than 1 ma. or less than 1/10 mw. It is made in two general types — the single-coil voltage-sensitive type, and a double-coil differential current type. A wide range of coil sizes are available to meet a variety of current, voltage, and sensitivity specifications. It is applicable to many different types of control circuits such as conventional bridge circuits, electron tube circuits, and any similar arrangement where an unbalance will impress a voltage on the coil (or produce a current differential in the two-coil type). The mechanism is mounted on a bakelite base with a transparent cover. Dimensions are 2-5/16" x 1-7/8" x 1-7/16". Weight is approximately 6 ounces.

Write for Data Sheet

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Position open for Project Engineer having a minimum of 5 years transmitter experience. Activities include design and manufacture of high and medium power transmitters, frequency shifters, communication terminal equipment and other communication products. NYC Area. Salary open.

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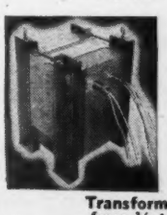
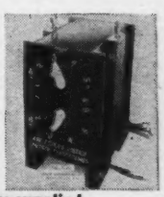
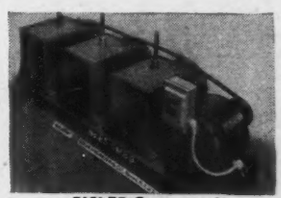
TRANSFORMERS in all types—furnace, distribution, power, phase changing, air, oil, induction, water cooled, plate, filament and auto-transformers. Filter chokes and inter-phase reactors.

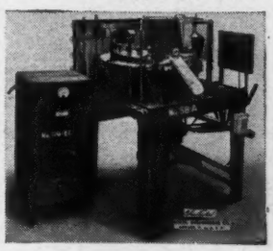




Transformers supplied from ¼ to 300 KVA.



EISLER Compound Vacuum Pump.



24 Head Radio Tube Exhausting Machine.

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*EISLER machines are in use and in production by 99% of all American radio tube and incandescent lamp manufacturers and throughout the world.

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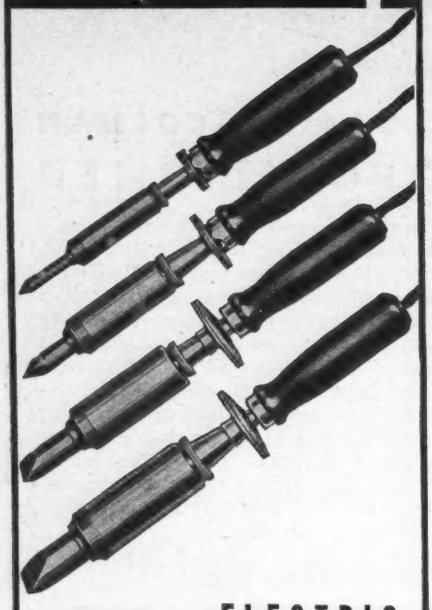

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are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.

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TEMPERATURE REGULATING STAND

This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.

For descriptive literature write 111-1

AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICH., U. S. A.

Electronic Uses For Beryllium

"Beryllium products were so scarce during the war that imports of ore by air from South America were sometimes necessary and the total imports soared to ten times the pre-war figure," reports Arthur D. Little, Inc., in its "Bulletin".

"Beryllia, as berryllium oxide is commonly known, can be used as a refractory at extremely high temperatures, around 4000° F., where it is said to show high electrical resistivity and thermal conductivity and the best resistance to rapid changes in temperature of any commercial refractory. Fused beryllia can be obtained to almost any desired mesh characteristic and is adaptable to producing shaped ceramic objects. It has been considered for crucibles for casting metals which melt at unusually high temperatures, as well as for electrical insulators, combustion tubes, linings for high-temperature furnaces, and similar application. Recent work indicates that by special fabrication refractory bodies of fused beryllia can be rendered gas tight. Beryllia, widely used in the 'phosphors' coated on the inside of fluorescent lamps, extends the color range and intensity of the tube's glow. Beryl, the ore of beryllium, has long been used in vitreous enamel compositions to clarify chrome colors; now beryllia can reportedly be used to advanage with the less active beryl.

"Beryllium sulfate is used with zinc and cadmium salts to increase the glowing period of phosphorescent compositions, such as have been used in direction indicators for blacked-out ships and in printing inks for after-dark advertising displays. Compounds of beryllium with stearic and similar organic acids to form 'soaps' are useful as additives to make the viscosity of printing ink more uniform. The potentialities of the beryllium compounds have not yet been thoroughly investigated, but enough has been learned to suggest them as additives for many specialty applications.

"Copper alloys containing about two per cent beryllium show remarkable retention of elasticity; even under conditions of heat and corrosion, springs made of this alloy are unusually uniform in strength. The alloy is also unusually hard, conductive of heat and electricity, corrosion resistant, and low-sparking. It was used extensively

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- Sturdy Steel Case
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- Stand it up or Lay it Down

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40 Watts Input
TRANSMITTER KIT
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Complete including all parts, chassis panel, cabinet, less tubes, coils, and meter.
Wired by our engineers, Cat. No. 70-312....$75.00
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It has everything! Capable of 40 Watts input on C.W. and 25 Watts input on phone on all bands from 1500 KC through 28 Megacycles. Has three bands, all pretuned and available at the turn of a Switch, 10, 20, and 80 meters and uses two power supplies.

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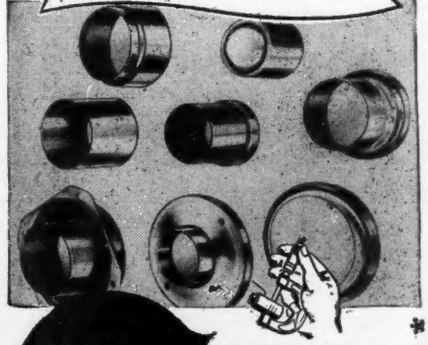

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Specialized DKE experience — over 20 years in the field — is now available for the production of stamped metal parts. All types of cups, sleeves, flanged shapes, intricate single pieces or fabricated components are included. High quality workmanship to exacting specifications—with any desired finish — is embodied in every job.

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during the war in precision instruments, aircraft-engine components, Signal Corps apparatus, and safety tools for munitions plants. Other alloys containing as little as 0.1 per cent beryllium are less expensive and give promise, especially where high electrical conductivity is required.

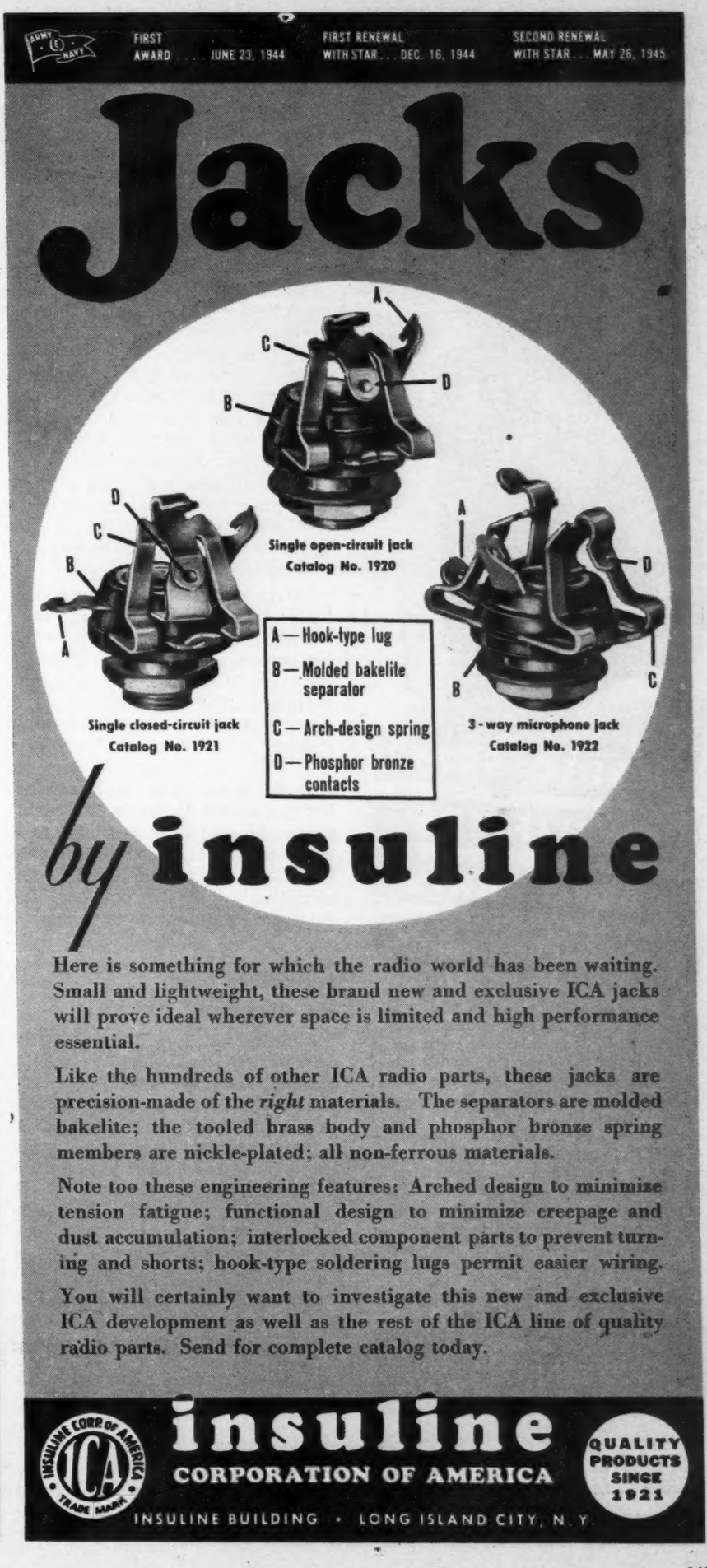
"Beryllium as a pure metal remains a rarity because of the difficulty of producing it; it is used principally for x-ray tube windows, where its heat resistance and high transmission of x-rays are attractive. Beryllium is the lightest of the stable metals, but so brittle that it has not been used structurally, even if its cost is disregarded. Alloys of 40% beryllium and 60% aluminum are remarkably elastic, tough, and machinable, but too costly. Beryllium has advantages as the 'moderator' for slowing neutrons in the plutonium pile used in atomic-bomb production, but was rejected in favor of graphite because beryllium was not available in sufficient quantity."

Infrared Autographs

Dr. R. B. Barnes, American Cyanimid Co., Stamford, Conn., has developed several interesting results in his research in infrared spectroscope analysis. Infrared invisible light is emitted by any hot object. The frequency range of these infrared vibartions embraces the range of molecular vibrations. Within each molecule the atoms which compose it are vibrating in a complex of several rhythms; to compute the number of such vibrational frequencies, one can, in general, multiply the number of atoms by 3 and deduct 6. There are some exceptions to this rule. The frequency of these vibrations varies for the molecules of different materials according to the mass of the atoms, the binding forces between the atoms, the spatial configuration and symmetry of the molecule and the molecular environment.

If infrared rays are allowed to fall on a substance, and their frequency is gradually altered, the frequencies will successively reach the same frequency as that of one of the several molecular vibrations of the substance and the infrared rays will be absorbed instead of passing through undisturbed.

The location of all of the absorption bands of the substance provides valuable evidence for identification. The permanent record of the examination of a substance can be made with a simple mechanical


ARMY E NAVY
FIRST AWARD . . . JUNE 23, 1944
FIRST RENEWAL WITH STAR . . . DEC. 16, 1944
SECOND RENEWAL WITH STAR . . . MAY 26, 1945
Jacks
A
C
D
B
Single open-circuit jack
Catalog No. 1920
D
C
B
A
Single closed-circuit jack
Catalog No. 1921
A
D
B
C
3-way microphone jack
Catalog No. 1922
A — Hook-type lug
B — Molded bakelite separator
C — Arch-design spring
D — Phosphor bronze contacts
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Here is something for which the radio world has been waiting. Small and lightweight, these brand new and exclusive ICA jacks will prove ideal wherever space is limited and high performance essential.
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Note too these engineering features: Arched design to minimize tension fatigue; functional design to minimize creepage and dust accumulation; interlocked component parts to prevent turning and shorts; hook-type soldering lugs permit easier wiring.
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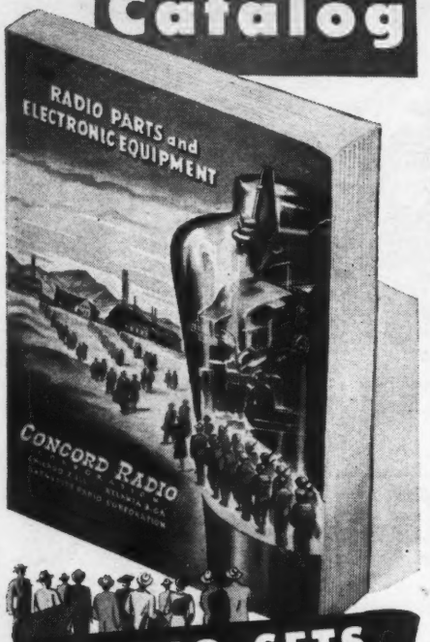

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pen device on a calibrated scale of frequencies. Thereby a pure substance literally writes its own unique autograph in a few minutes. A library of such autographs of pure substances properly cataloged for ready reference and comparison permits quick checks when examining unknown substances.

Beyond this, infrared spestroscopy is used to establish useful facts about the construction of given molecules with respect to the linkages between their atoms. For example, carbon-hydrogen linkage is fairly constant in interatomic distance, bond energy and bond strength. This implies a characteristic infrared absorption frequency for the C-H linkage. A study of autographs has shown that many atomic linkages have characteristic absorptions, which indicate their presence and sometimes provide evidence as to their relations to the rest of the molecules.

Infrared technics also provide a little used aid in synthesizing known materials. They are a help in following the alterations of molecular structure in cases where the atoms rearrange their linkages to give new properties to a substance. Such a case is the polymerization of thermo-setting resins: no material is added or removed; the heat causing the atoms to make altered attachments and a water-soluble resin becomes insoluble and infusible. Likewise it is possible to follow the oxidation of drying oils and the catalytic treatment of terpenes.

Serdex Is New Development Group

A group of well known former war project engineers has set up Serdex, Inc., 91 Cambridge St., Boston 14, Mass., to carry on development work in meteorological instrumentation, electronic applications and specialized communication problems. Associated with D. C. Bradford, formerly with Radiation Lab., M.I.T., and Signal Corps Development Laboratories, Fort Monmouth, N. J., who will be chief engineer, are: C. M. Hammel, formerly chief test engineer, Research Construction Corp., M.I.T.; W. K. Coburn, Jr., instructor in field communications, Harvard University, and research associate, Blue Hill Observatory; E. L. Sulkowski, formerly assistant officer in charge, ground instrument section, Evans Signal Laboratory, Belmar, N. J.; P. A. Hiltz, formerly production engineer, Polaroid Corp.

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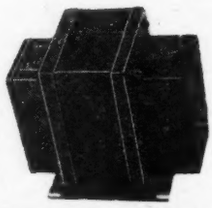

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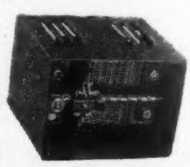

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Hewlett-Packard Audio Oscillator #200 B, freq. range 20 cycles to 20,000 cycles in 3 ranges. Complete with tubes and power supply, used, but reconditioned and guaranteed. $75.00.
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Send for our latest bulletin 40

N. Y. Electronic-Television Show, Oct. 14-19

Ninety thousand square feet of exhibit space on four floors of Grand Central Palace, Lexington Ave. at 46th Street, New York, has been leased for an Electronic, Radio & Television Exposition, to be open to the public from Oct. 14 to 19. The displays will be designed to "signalize for the American people peactime gains derived from technological wartime advances" and will be participated in by both the U. S. Government and by private exhibitors.

Dr. Robert A. Millikan and Dr. E. F. W. Alexanderson are announced as being members of a large advisory committee of important personalities figuring in the development of the electronic arts.

Edward L. Bernays is handling public relations for the show corporation, which is being backed by Brown Brothers & Harriman. Harry G. Cisin is executive director for the Electronic Exhibitors, 50 Broad Street, New York, N. Y.

Hermetic Products

Hermetic Seal Products Co., 416 Morris Avenue, Newark, N. J., listed in the May Directory issue of ELECTRONIC INDUSTRIES as manufacturing hermetically sealed components, produces a number of other allied products. These include crystal holders, hermetic terminals, and terminal strips.

"Resistors, Inc." Set Up

Resistors, Inc., 2241 Indiana Ave., Chicago 16, has been organized by Joseph J. Cerny, formerly president and general manager of Lectrohm, Inc. The company will manufacture resistors, rheostats, small solder pots, metal resistor cages, rf and power line chokes, and custom made heating elements.

Acoustical Society Studies Speech

On May 10 and 11, 1946, the Acoustical Society held its Thirty-First Meeting at the Hotel Pennsylvania, New York City. Quite a few of the fifty-seven papers read were of interest to electronic engineers.

In particular, a general report was made by a group of Bell Telephone Labs. engineers on methods for obtaining a continuous and instantaneous visual record of the frequencies and characteristics of

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Standing only 37" high, weighing but 137 lbs., the Dillon Universal Tester checks wire, copper, aluminum, fabrics, steel, etc. for tensile, transverse, compression and shear strengths. Available in 7 capacities, with interchangeable dynamometers, the Universal will test from 0 to 10,000 lbs. Special gripping jaws are made for every requirement.

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Tests prove that workers, too, undergo strain and nervous tension on the job. That's why many factories urge workers to chew gum. Workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy. And the act of chewing helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety.

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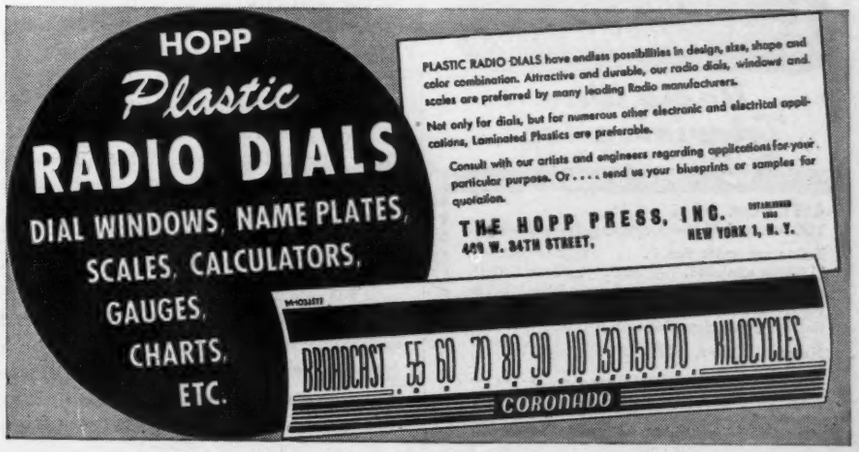
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Transmitter tube now being sold at $50 elsewhere —
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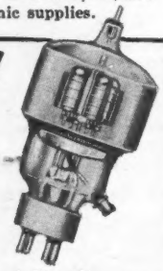

Another RWT achievement! Use this versatile transmitter tube as a modulator-oscillator-amplifier! Filament voltage: 5 or 10 volts. Plate voltage: 3,000 volts. Plate current: 900 ma. Plate dissipation: 300 watts. Limited quantity only.

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speech. This equipment, which in effect provides a continuous sound spectrum record of voice waves has been developed along several lines.

In one arrangement, a sample of speech to be analyzed is recorded on magnetic tape, and "exposed" over and over again to a group of twelve band pass filters having contiguous bands. The amplified outputs of these filters alter the intensities of 12 pin-point light sources which energize particular paths along a continuously moving phosphorescent belt, which retains its luminosity long enough to enable a viewer to get a complete picture of the analysis. This viewing screen handles three monosyllables/second and runs at a speed of 20 ft. per minute.

Visible speech

In another system a special cathode ray tube was rotated on its own axis. The cathode-ray tube screen is a cylindrical coaxial band. The electron beam always excites the screen in the same vertical plane. Due to the persistence of the screen phosphor and the rotation of the tube the impressed patterns are spread out along a horizontal time axis so that speech over an interval of a second or more is always visible. The upper portion of the screen portrays a spectrum analysis and the lower portion a pitch analysis of the speech sounds.

The translator has been used in a training program to study the readability of visible speech patterns. Spectrograms were shown for a wide variety of sounds, including voice sounds, animal and bird sounds, music, frequency modulations, and miscellaneous familiar sounds.

Engineers of the Bell Telephone Labs. also demonstrated a hundred-element tone synthesizer for generating a complex electric current wave, by the combination of independently controllable sine-wave currents picked off from adjacent channels on a magetic record. Special circuits were provided to alter the attack and decay time of the tones so that the characteristics of musical instruments of many types could be synthesized.

Two sessions dealt with the propagation of sound and ultrasonic waves in different media, the relation between certain atmospheric conditions and sound propagation characteristics, and with problems

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Again

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leads

In Ratio of Returns

It isn't often that a competitor will supply us with factual data confirming the large portion of ELECTRONIC INDUSTRIES' unduplicated circulation. One of the electronic magazines recently published in its house organ the number of inquiries received by a manufacturer of relays from advertisements run in the following list of publications. What the publisher neglected to add was that ELECTRONIC INDUSTRIES had received a higher percentage of returns per thousand circulation than their own magazine. Actually, it took 357 readers of that magazine to make one response. It took only 304 readers of ELECTRONIC INDUSTRIES to do likewise. Here's the way they compared:

Publication	Ratio of Returns Per M of Circulation
ELECTRONIC INDUSTRIES	**3.3**
An electrical publication	**3.2**
ELECTRONICS	**2.9**
An instrument publication	**1.9**
An electrical publication	**1.6**
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Weston, 517, 2½", ring mounted metal case, 0-15 volts 2.95
Westinghouse, NA-33, 2½", 0-150 Volts.... 1.98
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General Electric, A0-22, 3½", 0-150 Volts.. 5.50
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J.B.T. 34F, 3½", Frequency Meter 55-65 cycle, 11 reed, 100-150 Volts..... 6.00
Weston, 705, Sensitrol Relay, 0-100 Microamperes. Solenoid reset, S.P. normally closed 7.50
Western Electric, 3½", 100-0-100 Microamperes D.C. 4.00
Western Electric, 3½", 20-0-20 Ampere D.C. 3.00
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Western Electric, 3½", 0-1 MA D.C. movement, 0-20 K. V. Scale 3.00
Western Electric, 3½", D. B. meter —4 +6, 1 Milliwatt in 600 ohms, full scale —1 M.A. A.C. 5.00

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connected with the acoustics of rooms.

Two other sessions considered the various characteristics of human hearing, including studies on intelligibility of speech under adverse conditions. The most favorable properties of apparatus designed for the hard-of-hearing or for the transmission of speech under abnormal conditions, such as high altitudes or radio range reception were given special attention.

Refinements in supersonic reflectoscopy were reported by T. A. Firestone and J. R. Frederick regarding the use of thickness resonance with either longitudinal or shear waves. On materials possessing elastic aeolotropy, shear waves at right angles to each other may be simultaneously produced which result in the reception of an "elliptically polarized reflected wave" using an analogy to optical polarization.

Emerson Takes General

General Instrument Corp. has emerged with Emerson Radio & Phonograph Corp., New York. General Instrument and its subsidiary, F. W. Sickles Co., will continue to function as a separate division of Emerson. There will be no change in management or personnel.

Guitar Pick-Up

National Polytronics, Inc., has been formed with headquarters at 162 Greenwich Street, New York and will manufacture electronic equipment. First product is a magnetic guitar pick-up. Amplifiers will follow.

Armour Reorganizes Recorder Activities

The magnetic wire sound recorder activities of the Armour Research Foundation have been reorganized and a Magnetic Recorder Division established.

The Wire Recorder Development Corp., which in the past has been in charge of the Foundation's commercial activities in connection with magnetic wire recording, has been dissolved. The new division will maintain its offices in the same location, 135 South LaSalle St., Chicago.

Headed by Carl L. Titus, former engineering advisor, the Magnetic Recorder Division will coordinate all sound recorder activities, including the Foundation's licensee technical service, research engineering service, and licensing negotiations

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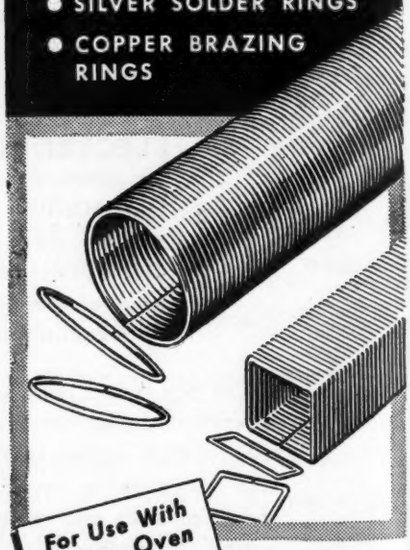

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with manufacturers to produce Armour magnetic wire sound recorders.

The licensing of four additional companies brings the total to thirty.

Thin Slicing

For use in the electron microscope material is now being sliced to a thinness of five to thirty millions of an inch. Five millionths of an inch is approximately half the wavelength of blue light. The method of cutting these extremely thin slices was developed in the laboratory of the Interchemical Corporation by Drs. Ernest F. Fullum and Albert E. Gessler. The secret is the use of a very high speed knife rotating 57,000 times a minute. Most materials show a very brittle characteristic at this cutting speed of 1,100 feet per second. One of the problems that was proved bothersome in this thin slicing operation is the accumulation of electrostatic charges on the slices.

Diathermy Standards

Engineering standards and technical requirements to prevent harmonics and interference to television and FM broadcasting and police radio, particularly, from electronic-medical diathermy equipment were formulated at a recent conference between the FCC engineering staff and over a score of manufacturers in this field. As the result of discussions of the minimum technical requirements, it was felt that the FCC Engineering Standards under which the Federal Commission will issue Certification of Type approval of diathermy equipment that has been tested will receive an early ratification by the Commission itself.

The minimum technical requirement for electronic diathermy equipment provide for operation on 13.66, 27.32, and 40.98 megacycles and the frequency tolerance and bandwidth for such apparatus was established as follows:

Center Frequency of Channel	*Band Width of Channel % of Center Frequency*	*Band Width of Channel (Kilocycles)*
13.66 Mc	±.05	15
27.32 Mc	±.5	270
40.98 Mc	±.05	40

The minimum technical requirements for which a certificate would be given included: Frequency stability of 0.02%; guaranteed frequency stability for one year; radiation field from diathermy machine not to exceed 25 microvolts per meter at 1,000 feet from machine; and the overshielding and field reduction must be such that the field due to skywave at distances greater than 1,000 feet shall not exceed 15μv/m. Frequency deviation over a normal treatment cycle of 20 minutes shall not exceed 1/3 of the authorized bandwidth of channel and the diathermy machine shall maintain its starting frequency to within 1/3 of the authorized frequency tolerance for a continuous eight-hour full-load test.

Radio Facsimile Transmitted to Train

Radio engineers of the Baltimore and Ohio Railroad, Bendix Radio Division of Bendix Aviation Corp. and Press Wireless Mfg. Corp., cooperated in a successful demonstration of radio facsimile transmission from a fixed to a moving station on VHF using shift phase modulation, June 4. They sent a facsimile reproduction to a moving Baltimore and Ohio train proceeding from Baltimore to Washington. The facsimile equipment for the demonstration was furnished by the Press Wireless and the radio transmitting and receiving appara-

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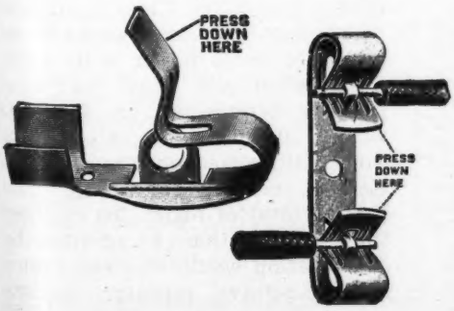

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tus by Bendix. Facsimile signals, after amplification, were sent on low frequency from the facsimile scanner by land line to three train radio stations along the Baltimore and Ohio right of way, one approximately two miles outside of the Union Station in Washington, the second sixteen miles away at Laurel, Maryland and the third at Relay, Maryland, eight miles from Baltimore. Each of the three train radio stations was equipped with Bendix Type MRT-1B transmitter-receiver unit, a Type MS-102B remote control box, a power supply and Type MS-110A Broadband Biconical Antenna. Aboard the train was a Type MRT-1B Communications Unit, identical to those at the fixed stations, a dynamotor power supply, a remote control box and a MS-101A ground plane antenna.

The facsimile equipment consisted of a scanner set up in the Capitol building at Washington and a page recorder installed in an office car attached to the moving Baltimore and Ohio train. Both facsimile units were standard Press Wireless design and construction is identical with other such units which the company made for the armed forces during the war.

Bus Communications Plan National System

No direct opposition to the petition of the National Bus Communications, Inc., that it be allowed to set up a highway radiotelephone service for its member bus companies, was presented at hearings held early this month by the FCC but the representatives of the American Telephone and Telegraph Co. did submit suggestions that experimentation in the field should be continued with determination to be made later by the Commission on control of the service as well as frequencies to be used. Opposition was also raised by A.T. & T. to any move that might infringe on common carrier frequencies. An early decision on the matter was indicated by the FCC.

Frank W. Walker, chief engineer and Thomas R. Warner, operations engineer of National Bus Communications (NABCO) were principal witnesses for the organization and presented detailed plans of construction and operation of a country-wide system of radio communication which would include three classes of terminal stations, a system of microwave repeater stations between terminal points and upwards of 15,000 mobile radiotelephone transmitters and receivers in motor coaches.

Under the NABCO plan the country would be divided into seven areas, each to have a separate channel of two frequencies. The organization did not specify what frequencies it would use but under the present FCC allocation plan for experimental use in this service it was indicated that 42-44 megacycles would be used with the fourteen planned frequencies to be 80 kilocycles apart. It was indicated, however, that the bus communications service might better be served in a higher frequency range, possibly between 152-162 megacycles which is largely being used for railroad radiotelephone.

NABCO's Class I stations (main terminal) would operate on 250 watts power with an estimated range of 60 miles. Class II stations (secondary terminals) would be set up for 50-watt power with a 30-mile radius and Class III (local transfer terminals) on 50 watts with a 20-mile radius. All stations would utilize frequency modulation. NABCO, for its initial set-up, would have a total of about 300 of these three-class stations. In addition the organization would also erect some 500 microwave repeater stations

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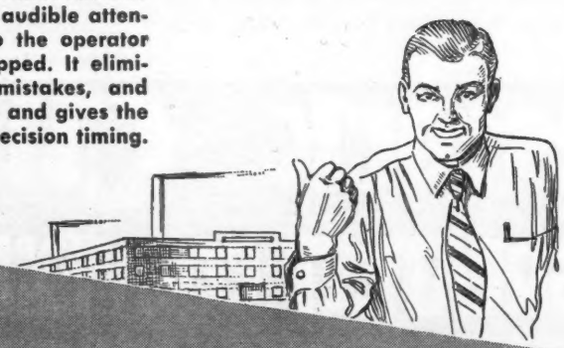

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WE Crystal 1N22 new sealed in lead 2 for...	1.50
WE Crystal 1N23 new sealed in lead 2 for...	1.80
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along bus traffic routes. This phase of NABCO's proposed plan received some criticism from the A.T. & T. witness, F. M. Ryan, radio coordinator, who pointed out that the UHF tubes necessary for such equipment have not been found satisfactory for remote, unattended stations. It was pointed out that duplicate equipment would be required for uninterrupted operation and thus raise NABCO's cost estimates considerably.

The bus companies' stand for operation of their own radio facilities received support from three industry representatives—Dr. D. E. Noble, general manager and director of research for the Galvin Mfg. Co.; Norman C. Crabbe, in charge of pacific sales for Bendix Radio Division; and Lee Chestnut, engineer of General Electric Co. All three witnesses termed the NABCO plan "sound" and feasible. Noble and Crabbe declared their companies had experimented with microwave repeater stations as proposed for the bus routes and found performance satisfactory. Mobile units for the buses, they said, could be produced by their companies for about $400 each.

NABCO expects to invest about $2,200,000 for its initial installation of 300 Class I, II and III stations and 500 microwave repeater stations. In addition the organization foresees some 15,000 buses using mobile radiotelephone equipment which, at $400 per set, as estimated by the witnesses at the hearing, would mean an additional investment by bus companies of some $6,000,000.

The A.T. & T. witness also outlined plans of the Bell System for urban and highway mobile service and revealed that the telephone companies would have urban stations set up in 43 cities by the end of this year. Construction permits have been granted by the FCC for 36 installations and the first station was put into operation in St. Louis late last month. Highway mobile installations, Mr. Ryan said, are planned for 30 locations this year with one completed in Green Bay, Wisconsin. The Commission has granted construction permits for 13 and 15 more are pending.

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Cornell-Dubilier Electric Co. has purchased the eight story building at 6-22 Grafton St., Worcester, Mass., in which it manufactured proximity fuse condensors during the war. The Navy owned machinery and equipment also will be acquired.

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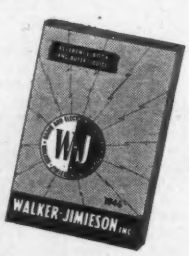

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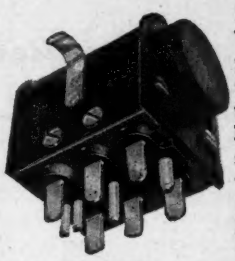
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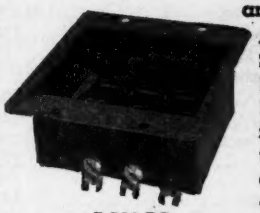
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